THE PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

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" Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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THE PHILOSOPHICAL MAGAZINE.

I. *Account of the Voyage undertaken by the Spaniards to the North-west Coast of America in the Year* 1792*.

As the Spaniards had only very imperfect information in regard to the channel de Fuea, situated in about lat. 48° 30′, two frigates, La Sutil and La Mexieana, were fitted out, in the year 1792, for the purpose of exploring it. They sailed from Acapulco, and arrived at Nootka Sound on the 13th of May. Macuina, the *tais* or ehief of the Indians of that distriet, immediately went to meet them in a canoe; and, having found three officers whom he had seen the preeeding year, he reeeived them with great cordiality. This prince is mueh praised by the Spaniards for his justice, beneficence, and humanity. The crew of an American vessel, commanded by eapta'n Gray, had a violent contest with these poor Indians respecting the price of some beaver skins, exchanged for a certain quantity of copper. As seven of them were killed and several wounded during the affray, Macuina came to the Spaniards to complain, protesting to them, with tears in his eyes, that his people had not merited that act of violence. At another time he came to seek consolation for his grief:—"I have eondemned to death," said he, "one of my subjects for offering violence to a girl of nine years of age; and I have absented myself from the place of punishment, that I may not hear the groans of the criminal." He had, however, his moments of energy. One day captain Quadra, who eommanded at Nootka for the king of Spain, saw one of these Indians running towards him. He was a criminal, who eame to beg he would intereede in his favour. Quadra interceded, and Macuina pardoned him; but he added with firmness: "Hear me, Quadra; this man shall never be again admitted among us.

* From the *Annales Litteraires.*

Let him remain with you: cause his hair to be cut off; let him be dressed as a Spaniard; and remember my clemency on the day when I shall come in my turn to demand pardon for one of thy people."

On another occasion he was less laconic, but equally ingenuous, in expressing his sentiments. The commandant, Quadra, suspected two Indians, Frijoles and Augustin, of having assassinated a young Spaniard. Macuina undertook to be their advocate; and, having waited on Quadra, he addressed him as follows, after a short preamble, in which he stated the circumstances of the case:

"I do not believe that you can impute to me this bad action. You have given me copper; I have received from you a great many shells for the fête of my daughter. It is from you I received the cloth, jewels, coat of mail, iron instruments, glass, and many other things with which I am provided. Our mutual confidence has been carried so far, that we have both slept in the same chamber, where, while you remained without arms and without soldiers to defend you, I might have taken your life, had a friend been capable of treachery. You entertain a mean idea of me and of my dignity, if you imagine that I would cause to be assassinated a child, less capable of defending itself than a woman. You would be the first whose life would be exposed to great danger were we enemies. You know well that Wicananish * has a great many fusees, with plenty of powder and ball; that captain Hana has not a few; and that both these as well as the Nuchimases are my relations and allies; and that, united, we would form a number far superior to that of the Spaniards, the English, and Americans, all together. Could we then be afraid of engaging in combat? Have not you often been badly attended, and have you ever observed any thing else than that my subjects flocked round you to give you every testimony of friendship? Why then do you allow your people to speak so disrespectfully of me? Make known to them all, that Macuina is thy real friend; and that, far from doing hurt to the Spaniards, I am ready to avenge the injury done to you, as I conjecture, by the perfidious people of Iticoac. You know the strength and intrepidity of my brother Quat-Laza-Pé, and of my relation Nutzape. Lend me five or six pedereroes; I will dispatch them both, with the most valiant of my Mischimis, to destroy these banditti, and to scour the neighbouring coasts. You may embark such of your people as you think

* One of the neighbouring *tais*, or princes.

proper,

proper, in order that they and mine, as well as our enemies, may know that Macuina is the same as Quadra, and Quadra the same as Macuina."

Some of the customs of these people must appear very singular to the Europeans. The father of a new-born child, if a tais, shuts himself up in his hut, without looking either at the sun or the waves. To be wanting in this respect would be a serious offence towards the *Quautz*,—such is the name given to the supreme Being,—who would destroy both the father and the child. The child at the end of a month receives from the grandees assembled a first name, which is changed when it quits the period of infancy; a third name is given to it at the epoch of puberty, and a fourth at that of youth: a new name is also given when it attains to maturity.

Girls, when they become marriageable, change their name also. This is a period of rejoicing for the whole family. The Spaniards of Nootka were present at a fête given by Macuina on a similar occasion. He caused his daughter, dressed with a profusion of ornaments, to appear in an alcove, from which he cried out to the assistants, "My daughter Apenas is no longer a child, but a woman: henceforth she shall be called *Isticoti-Clemoe*;" that is to say, the grand *Taysa of Yucuatl* *; to which all the spectators answered by loud and repeated shouts. Figure-dances were then performed by the tais and nobles. There were also different sorts of games, among which was wrestling. The Spaniards entered the lists, and obtained prizes of greater value than the wrestlers of the country. The good Macuina was highly gratified by their taking a share in the fête. When it was ended he carried to his daughter the implements necessary for female labour, and said to her: "Let us go, my daughter; you are now a woman, you must now think only of the duties of your sex." Paternal advice was never more exactly followed. She attended to nothing but her domestic concerns. Apenas was simple and playful, and had often paid a visit to the Spaniards. The grand Taysa of Yucuatl, however, became grave and circumspect. She hardly returned the salutations of her old friends: she durst scarcely smile; and if she gave any answer when spoken to, it was only in a few words, and as if by stealth. The chief of the Spanish establishment, for whom her fa-

* This is the real name of that island to which the Europeans, for what reason is not known, have given that of Nootka, which bears no relation to any word in the language of the country except to *Nutchi*, which signifies a mountain.

ther had a real affection, could never prevail on him to bring her along with him. "No, no," replied Macuina: "my daughter is now a woman; she can no longer leave her house."

The manners of the tais himself displayed great singularity. When public calamities required fasting and prayer, he would repair to the place of worship, stretch himself out on his back with his arms folded over his breast, and remain in that posture several hours. He implored the divine mercy with loud cries, invoked the deceased tais, and begged them to attest that he was worthy of them. Sometimes he spent two or three days without taking any other nourishment than a few herbs and water. At other times he prayed in his own house, to conjure the bad weather which impeded hunting and fishing. He shut himself up in a kind of cupboard, having coarsely painted in it a hideous figure, the signification of which the Spaniards were not able to learn. He beat against the walls, and thundered forth his orisons with a loud voice. These noisy supplications were succeeded by a profound silence.

Such scenes could not fail to appear ludicrous to those who had never before seen any thing of the same kind. The Spanish navigators, being desirous to put to sea from Nootka in order to continue their observations, were prevented by contrary winds: Macuina immediately addressed his prayers to his god in order to obtain a favourable breeze; but he accompanied them with such strange grimaces that the Spaniards could not help laughing. Macuina observed it, and was much offended. This was the only time, perhaps, that they ever saw him in a passion. They endeavoured to appease him; and, as he was incapable of rancour, a reconciliation was soon effected.

These Indians believe that the soul is incorporeal, and passes from this life to another. The tais and their relations go to meet their ancestors in the abode of the Quautz. The Mischimis are transported to another place, to a prince whom they call *Izmite*. If a tais has been wicked, he is confounded after death with the plebeians.

The dignity of tais is hereditary. There were three reigning at Nootka in 1792. Macuina was the principal. The tais may have several wives; but they generally confine themselves to three. The wives bring with them no dowry; but, on the contrary, must be purchased: and for want of property the Mischimis are condemned to celibacy, as the greater part of what arises from their labour does not belong to them. Those who are married have only one wife, whom

 they

they receive from the hands of their prince as the reward of their services.

The inhabitants of Nootka do not amount to more than 2000. Of late, the venereal disease has been introduced among them; so that they are threatened with the fate of the old inhabitants of California, who have been almost entirely destroyed by this destructive scourge. But this is not the only inconvenience which attends their intercourse with Europeans. Luxury begins to make considerable progress among them, and gives birth to passions with which they were before unacquainted,—avarice and its shameful train; and Macuina, humane as he is, has already been obliged to establish the punishment of death in order to suppress theft.

But there are also indigenous vices in this quarter of the globe. The Indians of Nootka are anthropophagi. They do not deny it: and after all we have said of Macuina, will it be believed that he still adheres to this horrible custom? Captain Meares learned from two of his officers, that at every new moon a slave was killed to regale their master, and that this atrocious act was accompanied with mirth and amusements. The Spaniards, however, flatter themselves that since they have been settled at Nootka the manners of these people have become softened; whether the horror they expressed at this practice made an impression on their simple minds, the depravation of which cannot be incurable, or that the victims they sacrificed, being taken from among the prisoners of war, the source of them has been dried up by the peace which the inhabitants of Nootka have enjoyed since 1789.

We shall pass over what the editor of this voyage says in regard to the dress, ornaments, masquerades, arms, buildings, canoes, food, and occupations of these people. Particulars are given in regard to all these points, which are not to be found in the voyage of captain Vancouver. We shall only observe that the Indians of Nootka differ in nothing from the other American tribes but in the pyramidal form of their heads, which must be ascribed only to the strong ligatures by which they are compressed in the cradle. We shall add, that they are much less copper-coloured than the Mexicans, and that M. Pauw, had he seen them, would have ceased to maintain that all the inhabitants of America are beardless. The young Indians of Nootka appear, indeed, to have no beards, because they employ great care to pull the hair up by the roots; but adult males have beards like the Europeans, and the Spaniards have seen among

them old men with beards as long and as bushy as those of the Turks.

Their principal occupation, and the chief source of their riches, deserve some details. The natives inhabit only the coast, and abandon the interior of the country to bears, stags, lynxes, wolves, martins, &c. Of the marine animals which abound on their coasts the most valuable are no doubt whales, which supply them with abundance of food. They have also sea otters, the skins of which are the only money with which they traffic.

The sea otters are amphibious, but live for the most part in the water. They are found at a great distance from the coast, swimming on their backs, and carrying their young on their breast until they are in a state to swim themselves. In this manner they perform long voyages, for the purpose of finding the small fish on which they feed. They never abandon their young, even amidst the greatest dangers; and they can be torn from them only with their life. But this race of animals are daily decreasing, since mercantile avarice has caused war to be declared against them along the whole north-west coast, from lat. 36° to lat. 60°. There is not a single point of that immense coast where the Indians are not employed in hunting sea otters. It is with their skins that they have hitherto procured all their articles of luxury—copper, shells, &c. The lungs of these animals are so constructed that they cannot keep their heads below water for more than two or three minutes; which gives a great advantage to those who are in pursuit of them: but the velocity with which they swim often enables them to escape the dexterity of the most expert hunters.

The quality of their skins varies with age. When only a few months old they are covered with whitish hair of an ugly appearance, which soon drops off, and gives place to a shorter and darker kind. When they have attained to their full growth this hair becomes thicker and entirely black, and the skin acquires its full beauty; but it turns gray as the animal grows old. At all seasons the skins of the males are more valuable than those of the females.

It is seen by this short description, that the otters of the north-east coast of America differ in many respects from the land otter described by the naturalists of Europe; and even from the *saricovian*, a kind of sea-otter found on the coast of Brazil, and which abounds in particular on the eastern coasts of Kamtschatka. The sea otters of the north-west coast of America, though they live nearly in the same seas, seem to be far superior in regard to their black, thick, and

and silky furs, which are much sought after in China. On this account they have lately been an object of speculation to all those who carry on trade with that country. This competition could not fail of raising the price. It taught the Indians on the north-west coast the value of these animals. At first they disposed of the skins for a trifle. But for some years past they have endeavoured to give the law instead of submitting to it. An English captain, therefore, complained to the Spaniards in 1792, that the trade in otters' skins, which at first was so productive, appeared to him to have become much less so.

But it is time that we should follow the two Spanish frigates in their expedition, of which Nootka was the central point, and the results of which, combined with the accounts of captain Vancouver, leave nothing to be wished for in regard to that portion, hitherto so little known, of the north-west coast of America.

It has been already said that Macuina had offered up prayers to obtain a favourable wind to the Spaniards, who were tired of their long and useless stay at Nootka. The wished-for breeze at length took place, and Macuina had at least the merit of informing them that it was propitious to their designs, with which they had made him acquainted.

Having sailed from Nootka on the 4th of June 1792, they landed at the port of Nunez Ganoa, situated at the entrance and on the southern edge of the straight of Fuca. Fidalgo, captain of the Spanish frigate La Princessa, had begun to form there an establishment like that of Nootka. The tais of the district, named Tetacus, received the Spaniards with the sincerest cordiality. Under his auspices they explored in the creeks several interior channels of the Strait de Fuca. He even attended them as a guide, and when their course was opposed by calms or contrary winds he offered up prayers for them. He seemed to be held in great consideration along the whole coast, and to deserve it by his character, which exhibited a mixture of dignity and goodness; but, like his subjects, he participated in that superstition to which all uncivilized nations are so much attached. He really believed in the strangest prodigies, and endeavoured to make the Spaniards believe them also. He one day wished to persuade them that he had seen, not in a dream, he said, an eagle dart from the clouds, seize a whale, and carry it up into the air.

From the eastern shore of the Strait de Fuca they proceeded to the northern, followed it from west to east, explored several small islands, and entered into various small channels.

channels. Then doubling the south-east point of this great island, to which captain Vancouver, out of compliment to his friend the Spanish commander, gave a name composed of both their names united, *Quadra y Vancouver*, they proceeded to several islands of different sizes. They entered a winding channel which extends into the continent, and to which they gave the name of the famous minister Florida Blanca, with whose disgrace, however, they were no doubt unacquainted *. Approaching then to the western coast of the great island, they were exposed to some danger at the entrance of a bay which they named Porlier, from the name of one of the governors of the Spanish Indies. Having escaped this danger, they arrived, after much fatigue, at a creek in long. 118° and lat. 49° 15′, which they named Cala del Descanso; that is to say, the Bay of Rest, where they experienced, indeed, a transient cessation of their anxiety. They then found themselves entangled in this long channel of unequal breadth, which separates the island of Quadra y Vancouver from the continent.

On their approach to the channel of Florida Blanca they fell in with the English brig Chatham, commanded by captain Broughton, which formed part of the expedition under captain Vancouver, and which was employed in making a survey of the coast. Captain Broughton offered them his services, and, in return, the Spaniards informed him that in their preceding navigation they had explored the interior of the long strait as far as the point where they then were. Reciprocal testimonies of good will passed between both parties. National rivality is forgotten at such a distance from the mother country. They are no longer Spanish and English who meet; they are men united by dangers, by their wants, and by the common interest which they have in the progress of the sciences.

The Indians whom the Spaniards found at Cala del Descanso were little different from those of Nootka in regard to their conformation, but they had no resemblance to them in their manners and language. They appeared to be more suspicious and less hospitable than those of Porlier's Bay, which is at the distance of only eight or ten leagues. On this occasion the Spanish editor recommends to navigators not to judge of other tribes from what they have seen of one, though at a small distance from each other. The opposite coast soon justified this salutary advice. From the

* It took place in the month of February 1792, and the Spanish navigators were on this coast in the month of June following.

the Cala del Descanso the Spaniards proceeded to Point de Langara, which is on the other side of the strait, where they found Indians of a very different character. They had other countenances and other manners. The latter were a brave people. They were proud of their armour, and believed themselves invincible; but they were open, affable, and disinterested. They inhabit a peninsula of which Cape Langara forms the most northern point, and that of Cepeda the most southern. The Spaniards here rectified an error which had been confirmed by the observations of the preceding year, and which had made them believe that the two capes belonged to two different islands.

Near Point Langara they fell in with captain Vancouver himself, who went on board of their vessel and communicated to them his discoveries to the north-east of the great strait. The Spaniards were equally candid, and allowed that he had made several observations which had escaped them. Captain Vancouver proposed to them to sail in company, in the hope that some advantage might be gained by this union. The Spaniards consented, but were separated by contrary winds. The Spaniards dispatched two boats to examine the channel of Florida Blanca, and made some addition to the knowledge of it acquired by the English navigators. They explored the interior windings of this channel, which they were induced to consider as the long sought for passage; but they suddenly found it shut on all sides by mountains covered with firs, and having their summits inwrapt in snow. The Indians of this inhospitable region, who had never received visits of this kind, showed more of fear than curiosity. When they saw vessels of a new construction, some of them only had the courage to examine them; after which they fled into the woods.

Ascending then in a north-east direction, they did not think it necessary to explore the coasts adjacent to the mouth of the channel of Florida Blanca and that of Carmelo: trusting, says the Spanish editor, to the observations of the English, they were unwilling to lose time and consume provisions in useless researches.

Proceeding further, the English and Spaniards again met, and combined their operations in this strait, which sometimes expands and sometimes becomes narrow, presenting a multitude of isles, small channels, creeks, and bays, which extend more or less into the land. The Spaniards, in particular, discovered several anchoring-places, to which they gave names, and indicated their position in the maps which accompany their relation. It appears that they examined,

mined, with great care, the indentations of the American continent opposite to the large island of Quadra y Vancouver. At certain intervals they met with Indians, some of whom came to give them advice respecting the course they ought to pursue, while others fled on their approach; and some, conceiving their intentions to be hostile, began to put on their armour. The last approached them with otter skins in their hands, giving them to understand that they might take their choice, friendly commerce or battle. The first-mentioned, who were less suspicious, brought them fresh or smoked salmon, for which they took in exchange iron, shells, and other trifles.

On the 30th of July a violent quarrel had almost produced bloodshed. A group of Indians having attempted to wrest a fusee from one of the Spanish hunters, it was found necessary, before they could be dispersed, to fire a cannon and some musketry from the boats. The ball, however, did no execution; and the boats fired only with powder.

A serious subject of solicitude occurred soon after to the Spanish commandant. He had detached a boat with captain Vernaci, giving him orders to explore those parts of the coast which were inaccessible to large vessls. Vernaci entered one of the winding channels which penetrate a great way into the land between the lat. of 50° and 51°, and long. 120° and 121°. This navigation was in every respect dangerous. The boat had on board but a few articles for carrying on trade by barter, and Vernaci found it difficult to resist the importunities of the Indians, who were anxious to traffic with him. They were much surprised to see strangers approach their coast in this manner, and often manifested a desire of taking by force what the Spaniards were unwilling to give to them with good will. Vernaci was obliged to have recourse to mildness and persuasion. Though his crew had carried arms with them, it would have been imprudent to enter into a contest in which the neighbouring tribes would no doubt have taken a part. At length, having penetrated to the bottom of the channel or strait which extends beyond the 51st degree of latitude, and which has its own name in the Spanish maps and that of *Knight's Channel* in those of the English; and having ascertained that it had no outlet, he prepared to join his companions by another route. An Indian who appeared desirous of serving him, and who was actuated only by an evil design, offered to point it out to him. He, however, conducted him into a labyrinth of small islands, and then disappeared.

disappeared. Vernaci was then glad to return the same way he had come, and to proceed into the great channel. He had been absent ten days, and great apprehensions for his safety began to be entertained.

The Spanish navigators, being now joined, thought only of getting out towards the north-east from this long channel, into which they had entered about two months before: but they were not yet at the end of their labours. On the 9th of August they fell in with the English brig Venus, captain Henry Shepherd, which was returning from Bengal, and had touched at Nootka and the Strait de Fuca. From captain Shepherd the Spaniards learned that in this strait the Indians had killed the pilot of the Spanish frigate La Princessa. They sailed some time in company with the English captain; and the three vessels anchored within reach of two tribes, the Quacos and the Majoia, on the western coast of the great island, in about lat. 50° 40′, and a little to the east of long. 121°. They soon saw canoes approaching them in every direction, in one of which was the tais of the Majoia, who announced himself by presenting an otter's skin to each of the three commanders. These Indians brought a great many more, some of which were purchased rather through politeness than with a view to speculation; for they were much dearer than they had found them on the coasts of California. These Indians are well made, and have an easy gait, but a fierce and savage look. They seem to be exceedingly irritable. One of them who was unarmed, having quarrelled with a Spanish sailor, immediately disappeared to borrow a knife from one of his comrades; but he found on his return that the sailor was waiting for him with his drawn hanger. A great murmuring now took place among the Indians: they called with loud shouts for their tais, who was on board one of the Spanish ships; and it was not without great difficulty that tranquillity was restored and preserved until the moment of their departure, which took place soon after.

Next day they resumed their voyage, and, proceeding some leagues north-east, found good anchorage after they had passed a number of small isles. This place they named Port Guemes, from the name of the family of the viceroy of Mexico. As the wind was contrary, they remained here twelve days. They found here abundance of fish of different sorts; such as salmon, rays, soles, and small cod like those of Falkland's Islands. The Indians of Port de Guemes appeared to be very unsociable, and almost stupid.

Pursuing

Pursuing the same course along the coast they entered a very narrow channel, on coming out from which they found another port, which they called Gorostiza. They were now near the mouth of the great channel towards the north. Proceeding then south-east they arrived at Cape Scott, which is without the channel, and which is the most western point of the great island Quadra y Vancouver. Some leagues to the east of this cape, and in the open sea, there are two very large islands called those of Lanz. But when they arrived at that space of sea which separates them from Cape Scott, they were obliged to return to search for anchorage, which is at the mouth of the strait. Next day they steered for Nootka, where they arrived on the 30th of August, after employing four months in sailing round the large island.

[To be continued.]

LETTER IV.

II. *On the Catoptrical and Dioptrical Instruments of the Antients; with Hints respecting their Revival, or Reinvention, and Improvement in modern Times.*

[Continued from our last volume, p. 349.]

9. Thus, with the help of *Abat*, I have in some degree followed, without intending it, a plan I have somewhere seen recommended, namely, to prosecute historical inquiries backwards; that is, to begin with our own times, or rather with times not much anterior to our own, and proceed, by retrograde steps, to more antient periods, till at last we approach the wilds of uncertainty and fable.—I shall now add a few miscellaneous remarks and quotations; some of which did not before occur to me, and others could not well be introduced in my former communications.

10. And first, I think it right to lay before the reader the following passage from *Buffon*, which I have just found, and which, it must be owned, is not very consonant with the account of the destruction of the mirror of *Ptolemy Euergetes*, given by *Abat*, from *Crusius*. (See Lett. iii. § 52.) I have not the means of reconciling them; and, if I had, I am not sure that I should make the attempt. For the question is not, How, or when, or by whom, this optical instrument was destroyed? but Whether it really produced the effects recorded of it? And that it did, *Abat*, allowing

lowing for the mistakes of historians ignorant of optics, has made extremely probable, not to say absolutely certain, to those at least, who have the opportunity of repeating his very interesting experiments. *Abulfeda*, says *M. de Buffon*, in his Description of Egypt, has these words:—"*In Pharo Alexandriæ, erat speculum, e ferro Sinico, per quod a longè videbantur naves Græcorum advenientes; sed paulo postquam islamismus invaluit, scilicet tempore califatus* Walid-fil Abdilmelech, *Christiani, fraude adhibita, illud deleverunt*; that is, in the Pharos of Alexandria was a mirror of Chinese iron, by means of which the Grecian fleet, when at a great distance, was seen approaching; but, soon after Mahometanism prevailed, the Christians destroyed it, by stratagem *." In *Buffon's* opinion, the words *ferro Sinico* ought to be rendered *acier poli*, or polished steel. But this interpretation applies only to *ferro*, the abl. sing. of *ferrum* iron, and improperly excludes *Sinico*. I say improperly; for, of whatever kind the metal was, the historian certainly meant that it was Chinese. But why *Ptolemy's* opticians should have sent to China for iron or steel, which, the Sacred Writers assure us, were common in Egypt, does not appear. Being thus uncertain as to the precise *kind* of metal of which this famous telescopic mirror was composed, may we not ask, Whether *Abulfeda*, a historian who, it seems, was not over accurate, might not have written *ferro* for what is known to us by the name of Tutanag, a Chinese metallic compound, which might be valued then, as it is now, for the high polish it receives?

11. The Rev. *Mr. Nixon's* "Dissertation on the Antiquity of Glass Windows," in the Philosophical Transactions for 1758, mentioned above, is a sequel of "An Account of some Antiquities discovered at Herculaneum," in the volume for 1757. In the 13th article of this last paper, one of those subterraneous antiquities is described as "A flat piece of white glass, taken off from towards the extremity of the sheet; as appears from the curvature and protuberant thickness of one of its sides above the other parts." *Abat*, perhaps, views *Nixon* too much in the light of an opponent; for I do not find that the latter advances any thing inconsistent with the arguments and proofs of the former, except this observation:—"Before the application

* In *Playfair's* Chronology we find that *Walid* I., calif of the Saracens, reigned from A. D. 705 to 715, and *Walid* II. from A. D. 743 to 744; also that *Ishmael Abulfeda*, prince of Hamah, "an indifferent geographer and historian," was born A. D. 1273, and died in 1343.

of quicksilver in the constructing of *specula*, or looking-glasses (which I presume is of no great antiquity), the reflection of images by such *specula* must have been effected by being *besmeared* behind, or tinged through, with some dark colour, especially black, which would obstruct the refraction of the rays of light." But I presume that those who duly attend to *Abat's* quotations and reasonings, will be of opinion that *Mr. Nixon's* language is abundantly too strong, when he says that the antients *must* have so besmeared or tinged their looking-glasses; since *Abat* has clearly proved that they knew how to coat them with metal. Among other uses to which glass was applied by the antients, *Mr. Nixon* quotes from *Pliny* these passages:— "*Cum additâ aquâ, vitreæ pilæ, sole adverso, in tantum excandescunt, ut vestes exurant:* Glass globes, with the addition of water, when exposed to the sun, grow so hot as to burn clothes;" *lib.* xxxvi. *c.* 22. § 45. (The reader will observe *Pliny's* mistake in saying that the *globes* grow thus hot.) Again: "*Invenio medicos, quæ sunt urenda corporum, non aliter utilius id fieri putaré, quam crystallinâ pilâ adversis positâ solis radiis:* I find that medical men are of opinion, that there is not a more useful way to cauterize parts of the body, than by a crystal globe placed opposite to the rays of the sun;" *lib.* xxxvii. *c.* 6. § 10. *Mr. Nixon* adds, on the authority of *M. Renaudot*, in *Mem. de l'Acad. des Inscript. tom.* i. that glass was not wrought into lenses for optical uses, till the beginning of the thirteenth century; so that we may add his suffrage to those of the other learned fautors of *Roger Bacon's* pretensions. He also endeavours to make it probable, "that the original of glass windows may have fair pretensions to a place some years before the destruction of Herculaneum (*anno Christi* 80), in whose ruins the glass plate under consideration was buried." But he confesses, he "has not been able to trace up the use of glass in windows, by any positive authority, higher than about 200 years short of the epocha last mentioned, *viz.* to the latter end of the third century, when it is expressly mentioned by *Lactantius* (*De Opificio Dei, cap.* v.) in these words: "*Manifestius est mentem esse, quæ per oculos ea, quæ sunt opposita, transpiciat, quasi per fenestras, lucente vitro aut speculari lapide obductas:* It is more manifest that there is a mind, which sees things presented to it through the eyes, as through windows composed of clear glass, or transparent stone."

12. On this subject, it may not be amiss to add, that in the reign of *Tiberius*, according to *Pliny*, a Roman artist

had

had his house demolished, or, as *Petronius Arbiter* and others affirm, lost his head, for making malleable glass. In modern times, it is said, that in the year 1610, the sophy of Persia sent the king of Spain six glass vessels which bore the operation of hammering*.

13. *Abat* and *Nixon* do not appear to have extended their researches to the antiquity of glass in this part of the world; which is a point of some importance. I do not know any better proof that the antient inhabitants of this island, in particular, possessed the art of making glass, than the specimens of their work which still exist in the glass rings, with a round hole in the centre, and a very thick rim, in shape like the whirl of a distaff-spindle, but much smaller, which are found in many parts of the country. By the genuine descendants of the antient Britons, they are called *gleineu naidreedh*, or *glass-adders*. I have seen several of them, among the country people, in the south of Scotland, where their present name is *adder-stones*, to distinguish them, no doubt, from certain concretions there *said* to be formed in the heads of old toads, and called *toad-stones*. I remember a countryman picking up a greenish adder-stone, about 35 years ago, in a *peat-moss*, or turf-bog, in Dumfries-shire. He showed it to the late Rev. *Dr. Walker*, professor of natural history in the university of Edinburgh, then minister of Moffat, whose learning and ability are well known to proficients in that study. But the doctor, who was not very fond of giving his opinion in doubtful subjects, barely told the man that it was an *amulet*; a word as mysterious to him as the *modus operandi* of the thing signified. On consulting a dictionary, however, he found that the word amulet meant a charm; for those glass rings are thought to have been used as charms by the Druids; with whom, perhaps, originated the wild but wide-spread notion, that they were formed by adders or vipers. Certain it is, that their supposed virtues are still as much venerated by some of the Scottish peasantry, as was, among the Gauls, the *ovum anguinum* described by Pliny †. The good old women use them to rub the gums of children during dentition, and parts affected with pain in persons of all ages; and, perhaps, it would not be easy to prove them to be less efficacious than the modern *tractors*.

14. All the adder-stones I have seen, though evidently of glass, were opake, and some of them beautifully varie-

* *Harris's* Lex. Tech. Supp. and *Bailey's* Fol. Dict. 2d ed. art. *Glass*.

† *Nat. Hist. lib.* xxix. *c.* 3. as quoted in the Minstrelsy of the Scottish Border, vol. ii. p. 404.

 gated.

gated. But I would by no means insinuate that all adder-stones whatever are opake; and much less that the antient Britons did not possess the art of making transparent glass. Such a conclusion would scarcely appear more rational than it would be in our present antiquaries, if no antient vessels of transparent glass had been found, to deny that the artists of those days could make such glass; or that they could make window-glass, if the curious specimen, described by *Mr. Nixon*, had not been disinterred at Herculaneum.

15. Hence, on reflection, I cannot help wondering that some antiquaries, as observed in my last letter (§ 96), should believe that the antient Egyptians made opake glass, but *not* transparent glass. For, waving the well known logical principle, That negative propositions, such as this is, admit not of proof, it is allowed that those antients were acquainted with the reduction of metallic ores, and consequently with fluxes or vitrifiable substances, which, though opake when in thick masses, would transmit more or less light when, as would often take place, they happened to be sufficiently thin. A rude kind of transparent glass, thus obtained from crucibles or smelting furnaces, (not to mention potteries and brick-kilns,) would furnish a hint, which, it is natural to suppose, would not pass unimproved among so ingenious a people. Besides, it is very improbable that the manufacture of glass could flourish, as we have seen it did among the Sidonians, without becoming known to their enlightened neighbours the Egyptians; some of whose monarchs have immortalized themselves by their encouragement of the arts and sciences.

16. According to the venerable *Bede*, glass windows were first introduced into this country about the year 674, when *Benedict Biscop*, the cotemporary of the famous *Wilfrid*, bishop of York, founded the monastery of Weremouth. "After the work was far advanced, he sent agents into France to procure, if possible, some glass-makers, a kind of artificers quite unknown in England, and to bring them over to glaze the windows of his church and monastery. These agents were successful, and brought several glass-makers with them; who not only performed the work required by *Benedict*, but instructed the English in the art of making glass for windows, lamps, drinking vessels, and other uses *."

17. I have introduced these passages, to save the reader

* *Bedæ Hist. Abbat. Weremuthen.* as quoted in *Henry's* Hist. of Great Britain, vol. iv. p. 116. ed. 3.

the

the trouble of referring to other works, to satisfy himself that the art of making and variously moulding *transparent* glass, was practised in England above 500 years before the time of *Roger Bacon*; and consequently that he could be at no loss to procure that material for his experiments. But these remote historical facts must here give place to others, more immediately connected with the present inquiry. In "*John Dee* his Mathematicall Præface to Euclid, *Written*," to use his own words, "*at my poor house at Mortlake, anno* 1570, *Febr.* 9," I find the following curious, but long neglected, passages; which, had I known of them, should have been inserted before I arrived at this *miscellaneous* conclusion of my communications. I must observe, that the copy of *Dee's* "very curious and elaborate" preface, in 95 small 4to pages, now before me, is prefixed, not to his own edition of the Elements, which "was published by *Henry Billingsley* in 1570*, but to "Euclid's Elements of Geometry, the first VI books, in a compendious form contracted and demonstrated, by Capt. *Thomas Rudd*, Chiefe Engineer to His late Majesty; whereunto is added the Mathematicall Preface of *Mr. John Dee*: London: Printed by R. and W. Leybourn, R. Tomlins and R. Boydell, 1651." This date will account for the orthography and punctuation, which I copy, being more modern than that which was fashionable, in 1570, when this interesting preface was first printed.

18. *Dee* defines "*Perspective*" to be "an Art Mathematicall, which demonstrateth the nature and properties of all Radiations, Direct, Broken, and Reflected." And "*Glasse*," according to him, "is a generall name, in *Catoptrike*, for any thing from which a Beam reboundeth." —"Is it not greatly," he asks, "against the Soveraignty of Man's nature, to be so overshot and abused with things (at hand) before his eyes? as with a Peacock's tail, and a Dove's neck: or a whole ore, in water holden, to seem broken. Things far off to seem neer, and neer, to seem far off. Small things to seem great, and great to seem small. One man to seem an Army. Or a man to be curstly afraid of his own shadow. Yea, so much, to fear, that if you being a lone, neer a certain glasse, and proffer with dagger or sword, to foyne at the glasse, you shall suddenly be moved to give back (in manner) by reason of an Image appearing in the air, between you and the glasse, with like hand, sword or dagger, and with like quicknesse foyning

* See *Dr. Hutton's* Dictionary, article *Dee*.

at

at your eye, likewise as you do at the Glasse. Strange, this is to hear off, but more mervailous to behold, than these my words can signifie. And neverthelesse, by demonstration Opticall, the order, and cause thereof, is certified: even so as the effect is consequent. Yea, thus much more, dare I take upon me, toward the satisfying of the noble courage, that longeth ardently for the wisedome of Causes Naturall: as to let him understand, that, in *London*, he may with his own eyes, have proof of that, which I have said herein. A Gentleman*, (which, for his good service, done to his countrey, is famous and honourable: and for skill in the Mathematicall Sciences, and Languages, is the Odde man of this land, &c.) even he is able: and (I am sure) will, very willingly, let the Glasse, and proof be seen: and so I (here) request him: for the encrease of wisedome, in the honourable: and for the stopping of the mouths malicious: and repressing the arrogancy of the ignorant: ye may easily guesse, what I mean."—These last words will be best explained by the first sentence of the author's long and querulous "Digression Apologeticall:" —"And for these, and such like marvellous Acts and Feats, Naturally, Mathematically, and Mechanically, wrought and contrived: ought any honest Student, and modest Christian Philosopher, be counted and called a *Coniurer?*"—It appears that the foolish and superstitious multitude, not content with verbal abuse, destroyed the large collection of instruments, manuscripts, and printed books, which he had painfully amassed at Mortlake, in Surry, "*as belonging to one who dealt with the devil* †."—In another place, *Dee* has these words: "Of the strange self-moving, which, at Saint *Denis*, by *Paris*, *Anno* 1551, I saw once or twice (*Orontius* ‡ being then with me, in company) it were too strange to tell. But some have written it: and yet, I hope it is there, of other to be seen. And by *Perspective* also strange things are done: as, to see in the air aloft, the lively image of another man, either walking to and fro: or standing stil. Likewise, to come into an house, and there to see the lively shew of Gold, Silver, or precious stones: and comming to take them in your hand,

* S. W. P. on the margin.

† See Dr. *Hutton's* Dict., art. *Dee*, compared with this "Digression Apologeticall."

‡ Probably the great French geometer and mechanician *Orontius Finæus* (or *Oronce Finé*) who died A. D. 1555, after suffering much for an astrological prediction, which had offended the court of France. See Dr. *Hutton's* Dictionary, article *Finæus*.

hand, to finde nought but ayr. Hereby have some men (in all other matters counted wise) fouly over-shot themselves: misdeeming of the means."—Here it is observable that *Dee* does not, as in the former quotation, affirm that he *actually saw* these effects of perspective produced. The lord chancellor *Bacon* relates, that his great precursor and namesake, *Roger Bacon*, apparently walked in the air between two steeples, which he supposed was the effect of reflection from glasses, while he really walked on the ground*. And what *Dee* says of the "shew of Gold, &c." is apparently taken from the 5th chapter of *Roger Bacon's* tract *De Nullitate Magiæ*; though I do not find that the great author is mentioned, or alluded to, in this whole preface.

19. But the most extraordinary passage in this performance of *Dee*, is the following:—"No small skill ought he to have, that should make true report, or neer the truth of the numbers and summes, of footmen or horsemen, in the Enemies ordering. Afarre off, to make an estimate between neer terms of More and Lesse, is not a thing very rife, among those that gladly would do it."—"The Herald, Pursuivant, Serjeant Royall, Captain, or whosoever is carefull to come neer the truth herein, besides the Judgment of his expert eye, his skill of Ordering *Tacticall*, the help of his Geometricall instrument: Ring or Staffe Astronomicall: commodiously framed for carriage and use.) *He may wonderfully help himself by perspective Glasses.* In which, (I trust) our posterity will prove more skilfull and expert, and to greater purposes, than in these dayes, can (almost) be credited to be possible."

20. I apprehend that this last passage must be admitted as a decisive proof, that "perspective glasses," and some of their most useful effects, were known in England, in 1570; or more than 40 years earlier than 1609, or 1610, when they are commonly believed to have been invented in Holland. I say *more than* 40 years; for *Dee* here talks of them as we should do of instruments familiarly known, but in the use of which we were not so "skilful and expert" as, we "trusted, our posterity would one day prove;" probably because they had not yet been reduced to a very commodious form. Thus much the words of *Dee* clearly warrant us to affirm; but *how much* more than 40 years, they do not authorize us to say. Nor will *Dee's* words enable us to ascertain whether his "perspective glasses" were dioptrical or catoptrical; for his definitions above inserted, of "perspective"

* See Dr. *Hutton's* Mathematical Dictionary, article *Optics.*

and "glasse," contain nothing to prevent us from applying them to either kind of "glasse;" and our extracts from *Abat* show that distant objects may be viewed advantageously with both.

21. From the whole of what has been stated, in my four letters, I may now venture to draw a few of the many inferences, which cannot fail to force themselves on the mind of the intelligent reader; but which, in order to avoid all dogmatism, I shall express in the form of queries.

22. Preparatory, however, to my first query, I must observe, that the celebrated *Dr. Zach*, of Saxe-Gotha, in examining, as he did in 1784, the unprinted papers of our great *Harriot*, found that his observations on Jupiter's satellites extended from January 16th, 1610, to February 26th, 1612. The renowned *Galileo* discovered those secondary planets on the 7th of January 1610; "so that," says *Dr. Zach*, "it is not improbable that *Harriot* was likewise a first discoverer of these attendants of Jupiter."—"It appears that *Harriot* had telescopes with magnifying powers of 10, 20, and 30 times."—"And it is very likely that *Harriot*, who lived with so generous a patron as *The Earl of Northumberland*, had got the new invention of telescopes in Holland much sooner in England than they could reach *Galileo*, who, at that time, lived at Venice."—Now, *Harriot* was born in 1560, and died in 1621. The *Pantometria* appears to have been first printed in 1571 *, and a second time in 1591; and the *Stratioticos* first in 1579, and again in 1590. These two interesting books were the joint works of *Leonard Digges* and his son *Thomas Digges*, the former of whom died about 1574, and the latter in 1595, when *Harriot* was 35 years of age. *Dee's* Preface to Euclid was first printed in 1570, and its author lived till 1608, when *Harriot* was in his 48th year. These three performances, therefore, which, as we have seen, (Lett. ii.

* Here a friend obligingly sent me the first edition of the *Pantometria*, "imprinted at London *anno* 1571," when *Tho. Digges*, esq. the editor, and partly the author, says he was 25 years of age. Thus both editions of that work are before me; the first a small 4to. (1571), and the second a small fol. (1591) apparently much augmented. But I cannot compare them now.—The note at § 8. of my second letter should be read thus: The *Pantometria* was begun by *Leonard Digges*, and finished by his son *Thomas Digges*. The first of the three books of the *Stratioticos*, was begun and almost finished by the father, and the two others wholly written by the son. See the title of the first edition of the *Pantometria*, and the Dedication of both editions; also the Preface to the *Stratioticos*, and the List of *Tho. Digges's* works, at the end of it's Contents.

§ 3

§ 3 and 9, and § 18, 19, above) contain undeniable proofs of an acquaintance with some contrivance answerable to the telescope, could not but be known to *Harriot*, as well as, in all probability, the authors of at least two of them. Twenty years have scarcely elapsed since *Harriot's* astronomical writings were brought to light, or since that celebrated analyst, the instructor of *Descartes*, was at all known as an astronomer (a notable instance of our ignorance even of modern characters and events); and it seems by no means extravagant to suppose that future incidents or researches may furnish grounds for a decidedly affirmative answer to*

Query 1*st*. Whether it be not, at least, as probable that *Harriot's* telescopes were made in England as in Holland?

Query 2*d*. Whether it be not undeniable, that the *Diggeses* and *Dee* actually possessed some such instrument as a telescope; and whether *Thomas Digges* do not expressly ascribe his father *Leonard's* knowledge of optics partly to a written book of *Roger Bacon?* (See Lett. ii. § 3, 4, 9; and § 19 of this.)

Query 3*d*. Whether this express testimony of *Thomas Digges* do not strongly co-operate with *Roger Bacon's* own writings, in producing a conviction that he was acquainted with some instrument equivalent to a telescope; and whether, when he says, "*It is thought* that *Julius Cæsar* discerned through very large glasses," &c. he do not forego all personal claim to the invention of those glasses, and plainly imply, that it was believed by the learned of his time, that that invention was to be referred to a much more antient period, even to a period of *indefinitely* remote antiquity? For *Bacon* does not say that Cæsar *invented* those glasses, but only, that "it was thought" he *used* them.

Query 4*th*. Whether from the silence, as far as appears, of *Dee*, the *Diggeses*, *Recorde*, and *Roger Bacon*, respecting the invention of the optical devices they mention, we may not conclude (as *Abat* has done with regard to glass mirrors) that those optical devices are so antient that their inventors were forgotten; and whether this conclusion would not be strengthened by *T. Digges*' referring the knowledge of them (partly) to *Roger Bacon*, and *Roger Bacon* attributing the

* For the dates and facts mentioned in this paragraph, in addition to the authorities already cited, see Dr. *Hutton's* Mathematical Dictionary, articles *Dee*, *Digges*, and *Harriot*.

use of them to *Julius Cæsar*, while he says nothing as to the time and circumstances of their *invention?*

Query 5th. Whether the antient maxim of concealing from the people at large truths of which, it was supposed, they could make no good use; a maxim which, as we have seen, was applied to this very subject even by so modern an author as *Dr. Recorde*, did not peculiarly expose such truths, thus floating, so to speak, on the breath of a few adepts, to the danger of being lost in the revolutions which too frequently disturb or subvert society; especially before copies of what *might have been thought fit to be committed to writing** could be multiplied by the press? (See Lett. ii. § 16. 19.)

Query 6th. Whether, notwithstanding these disadvantages, considerable remnants of optical knowledge have not escaped the reserve of philosophers and the fury of revolutionists; and whether, if *Abat* and others have proved, or rather, if experiments prove, that simple lenses and concave mirrors have the same effects as telescopes; and if *Abat* has, moreover, made it probable that *Ptolemy Euergetes* applied a concave mirror to the same use; it would be absurd to conclude, that instruments equivalent to telescopes are, in fact, extremely antient? (See Lett. iii. § 12. 23, &c.)

Query 7th. Whether this conclusion be not additionally justified by the proofs, which the same author has adduced, of the dexterity of the antient manufacturers of glass; proofs which reach from very distant times down to the days of *Vitellio, Peccam*, and *Roger Bacon?* (See the former part of this letter.)

Query 8th. Whether, after the evidence stated (and much more might no doubt be discovered) it would be rash, or absurd, or inconsistent with the undoubted pretensions of modern inventors, to suppose that the knowledge of some such instrument as the telescope, has been concealed among the learned from very remote ages; and that, strictly speaking, such knowledge has only been published, and with other parts of optics, greatly augmented and improved, in modern times?

* *Dr. Hutton*, in his article *Galileo*, after enumerating the writings of that great man, adds: "Besides all these, he wrote many other pieces, which were unfortunately lost through his wife's devotion." (say *bigotry*) "who, solicited by her confessor, gave him leave to peruse her husband's manuscripts; of which he tore and took away *as many as he said were not fit to be published*."

These queries, together with the facts and reasonings on which they are founded, I humbly submit to the candid examination and criticism of men of more learning, ability, and leisure, than,

Dear sir, yours respectfully,

* D.

[Postscript in our next Number.]

III. *On the Decline of Mathematical Studies, and the Sciences dependent upon them. By the Rev.* JOHN TOPLIS, *A. M.**

It is a subject of wonder and regret to many, that this island, after having astonished Europe by the most glorious display of talents in mathematics and the sciences dependent upon them, should suddenly suffer its ardour to cool, and almost entirely to neglect those studies in which it infinitely excelled all other nations. After having made the most wonderful and unhoped-for discoveries, and pointed out the road to more; suddenly to desist, and leave these to be cultivated, and the road to more to be explored, by other nations, is very remarkable. It seems as strange as the conduct of a conqueror would be, was he to conquer all the countries around him, and then tamely to suffer his own and the subjugated ones to be possessed, governed, and cultivated, by those whom he had conquered.

It is a very great disgrace for a nation like this, which can proudly boast of a superiority over all others in arts, arms, and commerce, to suffer the sublimest sciences, which once were its greatest pride and glory, to be neglected. Surely a much more solid fame accrues to a people from their superiority in talents than in arms. Athens is as celebrated for its learning as its commerce or its victories. It cannot be owing to any want of importance in the sciences themselves that they are neglected; the discoveries made in them are of the most astonishing nature, and such as seemed absolutely beyond the reach of human intellect. By the marvellous assistance of the mathematics from the simple law of gravity are deduced the orbits of the planets and satellites, their distances, the times of their revolutions, their densities, quantities of matter, and many other remarkable properties too well known to be enumerated. Were it not for them, mechanics, optics, hydrostatics, geo-

* Communicated by the Author.

graphy,

graphy, and other branches of natural philosophy, would hardly have been known as sciences. It is possible that discoveries more wonderful and of greater utility than those already made by the help of mathematics, may some time or other be effected, should some great genius once point out the way. It is the opinion of many philosophers *, that the various forms and diversified properties of bodies are owing to the various laws of attraction and repulsion which their constituent particles exercise upon each other. Should these laws ever be discovered, we shall become as well acquainted with the structure, affinities, and mutual operations of bodies, as we are with the revolutions and actions of the planets upon each other.

The mathematics, and the sciences dependent upon them, cannot be neglected from their want of importance and utility: they are a much nobler study than the present favourite one of natural history, the various branches of which seem to require more the efforts of memory than judgment; in the pursuit of which, the highest object to be attained is the discovery of some nondescript insect or plant, in which chance more than judgment is concerned. Chemistry, from its very great importance as well as the utility arising from it, deservedly ranks next to mathematics and natural philosophy. But in chemistry, as well as natural history, we are left at so great a distance by the philosophers of the continent, that there are no hopes of coming in for but a comparatively very small share of praise.

We seem, as a nation, for this last half century, to be sunk into a great degree of supineness with respect to the sciences, regardless of our former fame. The generality of the papers in the Philosophical Transactions are no longer of that importance they were formerly. We have long ceased to study those sciences in which we took the lead and excelled, and are content to follow, at a very humble distance, the steps of the philosophers of the continent, in those which they have in a manner discovered and made plain by their glorious exertions. We, after having discovered and conquered regions in science, suddenly quit them to be possessed and cultivated by other nations, that we may pick up a few gleanings in the countries found out and cultivated by their exertions.

To what strange infatuation can it be owing that we tamely give up what was once our greatest boast? Is it,

* *Vide* Philosophical Magazine, vol. xiv. p. 194.

because

because a century back our philosophers made such advances in science that all other nations were left at an immeasurable distance, that we are contented with their glory, and think our country sufficiently immortalized? Can we tamely sit down with what they have done, and see other nations gaining fame where our ancestors immortalized themselves? By such conduct, the fame they have acquired reflects double disgrace upon ourselves; we show that we are degenerate, and unworthy of such fathers.

There are some remarks upon the importance and decline of mathematical learning in the *Encyclopædia Britannica*, article *Physics*, which I shall take the liberty of inserting, as the remarks of professor Robison will carry with them a deference not to be expected from those of one unknown to fame.

"A notion has of late gained ground, that a man may become a natural philosopher without mathematical knowledge; but this is entertained by none who have any mathematics themselves; and surely those who are ignorant of mathematics should not be sustained as judges in this matter. We need only appeal to fact. It is only in those parts of natural philosophy which have been mathematically treated, that the investigations have been carried on with certainty, success, and utility. Without this guide we must expect nothing but a schoolboy's knowledge, resembling that of the man who takes up his religious creed on the authority of his priest, and can neither give a reason for what he imagines that he believes, nor apply it with confidence to any valuable purpose in life. We may read and be amused with the trifling or vague writings of a Nollet, a Ferguson, or a Priestley; but we shall not understand nor profit by the truths communicated by a Newton, a D'Alembert, or De la Grange."—

"It is to be lamented that the taste for mathematical sciences has so prodigiously declined in this country of late years; and that Britain, which formerly took the lead in natural philosophy, should now be the country where they are least cultivated. Few among us know more than a few elementary doctrines of equilibrium; while on the continent we find many authors who cultivate the Newtonian philosophy with great assiduity and success, and whose writings are consulted as the fountains of knowledge by all our countrymen who have occasion to employ the discoveries of natural philosophy in the arts of life. It is to the foreign writers that we have recourse in our seminaries even for elementary treatises; and while the continent has supplied

plied us with most elaborate and useful treatises on various articles in physical astronomy, practical mechanics, hydraulics, and optics, there have not appeared in Britain half a dozen treatises worth consulting for these last forty years. It is therefore devoutly to be wished that the taste for the mathematical sciences may again turn the eyes of Europe to this country for instruction and improvement. The present seems a most favourable æra, while the amazing advances in manufactures of every kind seem to call aloud for the assistance of the philosopher. What pleasure would it have given to Newton or Halley to have seconded the ingenious efforts of a Watt, a Boulton, a Smeaton, an Arkwright, a Dollond! And how mortifying is it to see them indebted to the services of a Belidor, a Bossuet, a Clairaut, a Boscovich!"

Perhaps one reason to be assigned for the deficiency of mathematicians and natural philosophers is the want of patronage. These sciences are so abstruse, that, to excel in them, a student must give up his whole time, and that without any prospect of recompense; and should his talents and application enable him to compose a work of the highest merit, he must never expect, by publishing it, to clear one-half of the expense of printing. All those men, therefore, who have not fortune sufficient to enable them to give up their time in the study, and part of their property to the publication of works in these sciences, are in a manner excluded from advancing them. In France and most other nations of Europe it is different: in them the student may look forward to a place in the National Institute or Academy of Sciences, where he will have an allowance sufficient to enable him to comfortably pursue his studies; and should he produce works worthy of publishing, they will be printed at the expense of the nation.

It is remarkable, that amongst the very few men who still pursue mathematical studies in this country, a considerable part, instead of being dazzled and delighted by the wonderful and matchless powers of modern analysis, still obstinately attach themselves to geometry. It is a science, perhaps, of all others, from the clearness and accuracy of its proofs, the most proper to be taught young men, that from the study of it their reasoning faculties may be improved; but at the same time, as a science, it is confined in its application, feeble, tedious, and almost impracticable in its powers of discovery in natural philosophy. But what is called analysis possesses boundless and almost supernatural powers in its application to science; and the discoveries

coveries made by it in natural philosophy are of so surprising a nature, that to pretend to despise it, and obstinately to grovel amongst a few properties of surfaces and solid bodies, part of which were discovered by means of analysis, denotes a very narrow and prejudiced mind.

It is much to be wished that the few men who study analysis in this country, would cease to lose their time and mis-spend their talents in the discussion of vain subtilties, and cavilling with its first principles, (amongst whom the opposers of negative quantities cut a conspicuous figure,) but combine in exerting themselves to increase its power and riches; and endeavouring, in some degree, to keep pace with the analysts upon the continent in their discoveries.

I cannot here forbear making a few remarks upon the method of study made use of in the university of Oxford and the principal seminaries of this kingdom, as I look upon it as a very great interruption to the progress of science. Regardless of the wonderful advances made in the sciences and arts, they treat their learners with contempt, and, obstinately shutting their eyes against their present most enlightened state, seem determined that nothing but the study of words and ridiculous attempts at elegant composition in the Greek and Latin languages shall employ their scholars. Are the sciences which "weigh the sun and his revolving stars;" measure the velocity of light and the distance of the fixed orbs; draw the lightning from heaven; weigh the air; enable us to traverse the clouds; guide the mariner through the trackless deep; separate the rays of light; class the animated and decompose the inanimate bodies of the earth, measure and describe its surface, and bless its inhabitants by increasing the number of their enjoyments from their discoveries—to be utterly neglected, for barren unceasing attempts at imitating the style of Xenophon, Cicero, or Horace? Such a course of education, which insults reason and sets common sense at defiance, is so amazing an instance of folly and infatuation, that, although we have the strongest evidence of its truth, we can scarcely bring ourselves to believe it; and it almost inclines a person to suppose that it is a system formed with the intention of debasing and rendering ignorant, instead of improving the faculties of the mind. Had the same mode of education been pursued throughout Europe, science would have been checked, and the world could never have advanced beyond the knowledge of the Greeks and Romans.

It is not my wish totally to condemn classical learning, but the abuse of it. The Latin language, from the many valuable

valuable works of the Romans, from its having been for a long time the universal language of the learned in Europe, and the most important scientific works of the moderns being written in it, becomes a necessary study for the scholar. But to know the language well enough to read the works in it is sufficient, without mis-spending our time in a useless and vain endeavour to imitate the styles of its authors. I think the years consumed in learning Greek for the sake of reading half a dozen poets, historians, and orators,—for there are not more in that language whose merits render the originals superior to their translations,—as very ill spent, considering the present state of literature and philosophy.

Mathematics, and the sciences dependent upon them, ought to make the principal part of a good education. The strictness and accuracy of their reasonings would contribute in the highest degree to improve the mind of the student. By them he would learn to become patient in investigation, and severe in judgment. It would serve to check in him all conceited and arrogant pretensions to knowledge, and render him more diffident, by showing how careful and laborious it is necessary to be to acquire a few truths. They tend likewise to improve the morals, and give a steady serenity to the mind. In studying them, we seem to leave the jarring world, convulsed and rendered turbulent by the prejudices and frantic passions of men, to lead a life of pure enjoyment. In the pursuit of them we proceed by incontestable truths; every thing is certain, and the laws which take place throughout nature invariable. No prejudices, passions, or wrong bias of education, can involve us in errors and perplexities; any defect in the chain of reasoning can always be detected, and the mind may rest satisfied with the assured discovery of truth. How different is the case in other branches of learning! There, system after system bewilder and perplex the mind; every age produces different ones, which, after having flourished a short time, give way to others which fall in their turn. It seems, either from some radical defect in our modes of reasoning, or from our mental faculties having been vitiated and narrowed some way in our education, that we cannot proceed in our investigations in other sciences by clear and incontestable steps; or why should those truths which are mathematically demonstrated be the only ones received without opposition? The mathematical sciences are not only of the greatest importance to us from the beneficial effects attending their study, but at the same time most sublime in

their

their application. Through their assistance we become acquainted with some of the laws by which the omniscient and eternal Creator governs the universe, and are enabled to predict their effects in distant ages. Our condition becomes superior to the common lot of humanity, and we may be held out to the world as an example of the perfection to which it is possible for the human species to arrive.

Arnold, Nottinghamshire,
October 13, 1804.

IV. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* DAVID MUSHET, *Esq. of the Calder Iron-Works.*

[Continued from our last volume, p. 344.]

UNDER the same class of mixture the following experiments were performed:

VIII.	Pure silex six parts, or -	120 grs.
	Oxide of iron four parts, or -	80
	Charcoal 1-40th of the compound, or	5

This mixture was very perfectly reduced, and a glass obtained whose surface possessed a clouded coppery green colour. The fracture showed a much less perfect, though dense glass, the colour of which was a rusty yellowish green. Beneath was found a very neat spherule of malleable iron which weighed 12 grains, and equal to 6 per cent.

IX.	Pure silex - -	120 grs.
	Oxide of iron - -	80
	Charcoal 1-20th, or -	10

The result of the fusion of this mixture was a glass similar, though more perfect throughout, to the former. A fine metallic button was found below the glass which weighed 22 grains, and equal to 11 per cent.

X.	Pure silex - -	120 grs.
	Oxide of iron - -	80
	Charcoal, 1-10th, or -	20

This mixture approached somewhat to infusibility. A rough half vitrified green mass, very cellular, was found in the crucible. Two pieces of iron were found which weighed 26 grains, equal to 13 per cent. The colour of the earthy parts was a rich green mixed and spotted with rusty yellow.

XI. Pure

XI.	Pure silex - - -	120 grs.
	Oxide of iron - - -	80
	Charcoal 1-20th of the compound, or	20
	Pure chalk - - -	30

The fusion of this mixture afforded a very beautiful glass of a rich brown blackish colour, possessed of great smoothness and lustre. Beneath was found an elegant crystallized metallic button which weighed 50 grains; equal to 25 per cent. from the mixture.

In this experiment again, as in others formerly recorded, we have a direct proof of the useful agency of calcareous earth in the reduction and separation of iron from its earthy combinations.

Recapitulation of experiments with siliceous matter and oxide of iron in the proportion of six of the former to four of the latter.

Exp. II. 1-40th of charcoal yielded $1\frac{4}{10}$ per cent.
III. 1-25th ditto —— $7\frac{4}{10}$
IV. 1-20th ditto —— 9
V. 1-15th ditto —— 13
VI. 1-10th ditto not fused $12\frac{4}{10}$
VII. Being No. VI. repeated, with the addition of 80 grains of chalk, $20\frac{2}{10}$
VIII. With pure silex,
1-40th of charcoal yielded 6 per cent.
IX. 1-20th ditto —— 11
X. 1-10th ditto not fused 13
XI. Being No. X. repeated, with the addition of 30 grains of pure lime, 25 per cent.

One very obvious fact marks this table, namely, a great difference betwixt the quantity of iron revived when sand and pure silex were used. It may be proper here to remark, that Exp. VIII, IX, X, XI, where pure silex was used, were performed in crucibles made of Cornwall clay. If, therefore, there exists any tendency in clay under high temperatures to absorb the oxygen of the oxide, which I have suspected sometimes to have been the case; and if this affinity is exerted in proportion to the purity of the clay; a partial deoxidation of the oxide in these experiments may account for a larger portion of metal being revived with the same proportion of charcoal.

Third class of compounded ores consisted of
Well prepared chalk, six parts,
Oxide, four parts.

I. Mixture

I. Mixture - - - 500 grs.
Charcoal 1-40th, or - - $12\frac{1}{2}$

A black rough earthy glass was obtained by the fusion of this mixture, not unlike a furnace cinder. It was carefully examined, but without finding any trace of revived metal.

II. Mixture - - - - 500 grs.
Charcoal 1-30th, or - - $16\frac{6}{10}$

The glass obtained at this time was more perfect, glassy, and shining upon the surface. The interior very like finery cinder. There appeared no vestige of revived iron.

III. The same as before, performed with 1-20th, or 25 grains of charcoal. The glass had assumed a considerable portion of lustre and a few pearly shades upon the surface, but still there appeared no metallic produce.

IV. Mixture - - - 500 grs.
Charcoal 1-15th, or - - 33

A very perfect mass of glass was obtained by the fusion of this mixture. The surface was black, smooth, and shining: the fracture dense and opake. A neat metallic spherule was found which weighed 17 grains; equal to $3\frac{1}{2}$ per cent. The corrresponding experiment as to carbon with clay yielded 63 grains, and with silex 63 and 65 of iron.

V. Mixture - - - 500 grs.
Charcoal 1-10th, or - - 50

A perfect fusion and fine black glass were obtained, accompanied by a flattish metallic button of iron which weighed 58 grains; equal to $11\frac{6}{10}$ per cent.

VI. Mixture - - - 500 grs.
Charcoal 1-7th, or nearly - 72

A dark rich green glass was obtained in this fusion, and a bright silvery-coloured metallic button which weighed 124 grains; equal to $24\frac{8}{10}$ per cent.

VII. Mixture - - - 500 grs.
Charcoal 1-5th, or - - 100

This mixture fused, and yielded a fine crystallized button of steel. It was found to weigh - - 120 grs.
Globules thrown up against the top and sides of the crucible during ebullition - - 10

Total 130

Equal to 26 per cent.

The colour of the glass was light blueish green, very transparent in thin fragments.

VIII. Mixture - - - 500 grs.
Charcoal 1-4th, or - - 125

 The

The greatest part of this compound was reduced to perfect fusion. A small portion was found intimately connected, but in the state of a powder, upon the surface of the glass. The metallic button was similar to the last, and

weighed	- - -	120 grs.
Globules collected	- -	5
	Total	125

Equal to 25 per cent.

The glass was still more transparent than in the former experiment. The green tinge had entirely disappeared, and was succeeded by a lead blue colour, which always manifests itself when the separation of the metallic particles has been complete.

Recapitulation of experiments with chalk and oxide of iron in the proportion of six of the former to four of the latter.

Exp. I.	1-40th	of charcoal,	no iron revived.	
II.	1-30th	ditto		ditto
III.	1-20th	ditto		ditto
IV.	1-15th	ditto	yielded	$3\frac{1}{2}$ per cent.
V.	1-10th	ditto	——	$11\frac{6}{10}$
VI.	1-7th	ditto	——	$24\frac{8}{10}$
VII.	1-5th	ditto	——	26
VIII.	1-4th	ditto	——	25

The following table of comparison will, at one view, exhibit the very various results that take place in the process of separation, effected entirely by the nature of the earths, which in all cases must inevitably form a chief component part of our iron ores and iron stones.

General Table of the Results of the Fusion of Clay, Silex, and Lime, and Oxide of Iron, with various Proportions of Charcoal.

	Clay.		Silex.		Lime.	
Proportions of Charcoal.	Grains of iron revived.	Produce per cent.	Grains of iron revived.	Produce per cent.	Grains of iron revived.	Produce per cent.
1-40th	14	$2\frac{8}{10}$	7	$1\frac{4}{10}$	......	......
1-25th	46	$9\frac{2}{10}$	37	$7\frac{4}{10}$	......	......
1-15th	63	$12\frac{6}{10}$	65	13	17	$3\frac{1}{2}$
1-10th	not fu-	sible	not fu-	sible	58	$11\frac{6}{10}$
1-7th	ditto	ditto	ditto	ditto	124	$24\frac{8}{10}$
1-5th	ditto	ditto	ditto	ditto	130	26

Were

Were we to proceed to reason on what this variety of result depends, and referring to the experiments formerly communicated, we should have expected that clay and silex, each absorbing a considerable portion of carbon, would have required a greater dose in the experiments with oxide to have let fall the first portion of iron; and that, as calcareous earth betokened no affinity manifested in a similar manner to carbon, ores thus compounded would have let fall their metallic contents with the most minute comparative quantity of carbon.

The reverse of all this turns out to be the fact: for the argillaceous and siliceous compounds separate iron with the smallest portion of carbon; the calcareous compound requiring three times as much.

Hitherto we have discovered no direct active principle in calcareous earth, acting as a stimulant to the existing affinities betwixt carbon and iron, beyond facilitating, almost under every circumstance, the perfect fusion of the compound. If we suppose it to remain neutral in this respect, then, to explain the phænomenon of the argillaceous and siliceous compounds, we must suppose an active principle exerted by each of these earths, nearly in the same ratio, upon the oxide of iron, decompounding the oxide, and either liberating the oxygen or uniting with it. The removal of this immediately constitutes an affinity betwixt the particles of iron and the entire portion of carbon, the consequence of which is the revival of the iron.

That these conjectures are well founded, may be gathered from experiments similar to the following:

Calcareous earth six parts, or	-	-	120 grs.
Oxide four parts, or	-	-	80
Charcoal 1-15th of the whole	-	-	$13\frac{1}{3}$
To this were added of Cornwall clay		-	120

From the fusion of this mixture a neat metallic spherule was obtained which weighed 10 grains, and was equal to 5 per cent. This is the same, with regard to proportion, as Experiment IV, third class, with the addition of 120 grains clay; and it appears a fair consequence that $1\frac{1}{2}$ per cent. of more iron was revived.

There appears still another way by which we may in part account for the early separation of iron from the argillaceous and siliceous compounds.

In a former part of this inquiry it was shown that the combination of carbon with clay and silex did not produce full effect unless the latter entered into fusion; and it is evident from the foregoing experiments, that the compounds formed with

oxide and clay are more infusible than those formed by lime. The particles of clay and silex, therefore, being the last to enter into fusion, must be the last to exert their affinities upon the carbon. This being unacted upon, except by the oxide, readily unites first to carry off the oxygen, and next to impregnate the iron with carbonaceous matter.

If this takes place at an early stage of the operation, it is evident that the metallic result may be formed in consequence of the entire combination of the carbon before the earths have entered into fusion.

The quantity of carbon which the oxide of the calcareous compound takes up before any metal is allowed to fall, remains still unexplained, and appears a curious and very important fact, which cannot be solved by the last hypothesis. The presence of lime seems to prevent the immediate action of the metallic particles upon the carbon, but directs the whole force of the latter to the removal of the oxygen. By this means, however, it secures in the end a richer and more plentiful harvest of metal from ores similarly compounded.

The progressive stages of metallization are marked, in many instances, with a greater proportion of produce than in experiments with argillaceous and siliceous ores.

In the 1st class, the increase of the produce in iron, see
Exps. II and III, was 17 grs. for $8\frac{1}{3}$ carbon.
In the 2d class, —— IV and V, — 21 —— $8\frac{1}{3}$
In the 3d class,
or calcareous, —— V and VI, — 66 —— 22

[To be continued.]

V. *Letter from Dr.* Thornton *to Mr.* Tilloch *on the Cow-Pox; with an Account of the Cases in Fulwood's Rents.*

No. 1, Hind-street, Manchester-square,
October 15, 1804.

DEAR SIR,

The subject of the cow-pock is of such *general interest*, that I shall delay my fifth letter to Mr. Arthur Aikin, to say a few words on the late cases of supposed small-pox after the cow-pock inoculation so generally known in this metropolis.

Dr. Lettsom, in a letter to me on the receipt of my work entitled "Facts decisive in favour of the Cow-pock," which I presented to him, says, "that after what has been written by me and others on vaccination, the practitioner who now inoculates

inoculates with the small-pox, is guilty, if not in a criminal court, yet in *foro conscientiæ,* should that child die, of *murder* *." Whether he should die or not, I believe the same *serious* charge would apply; for, as the inoculated small-pox produces the natural small-pox, and pestilence spreads by an hundred avenues, and each contagion becomes a fresh focus of other infections, the seeming kindness granted to one human being is made the destruction of *many*; and this fact staring the practitioner in the face, he must be callous to all the feelings of humanity should he attempt, after knowing the mildness and certainty of the cow-pock, (except for experiment,) variolous inoculation: and as Fourcroy strongly expresses himself with regard to *pneumatic medicine,* so it may be said here, "It is now no longer permitted the practitioner to be ignorant of the circumstances attending such an important revolution in physic. The cold statue-like insensibility of some; the affected indifference of others; the irritated self-love of this man; the attachment of the world for the practice of their forefathers; the hatred of novelty; all the low and vulgar prejudices have at different times assailed this discovery: but it will stand as a rock against the impotent billows of human passions," and the superior sense of the philosophic world will overcome the sophistry of prejudices, and truth finally reign triumphant.

It is now evident that the small-pox has greatly decreased, and in a few years, most probably, will be annihilated; for although it assumes an hydra shape, yet, wanting fuel for support, this tremendous *fiend* must finally perish from the earth, and the cow-pox, like St. George and the Dragon, be the proudest emblazonment in the British heraldry.

In proof, in part, of this position, I shall beg leave to extract for you my experience in the North of England.

* The facts are so *decisive* in favour of the cow-pock, that the practitioner should listen to these; nor hearken to the evidence of a contrary nature without suspicion of some *mistakes* having occurred. At the onset my learned friend Dr. Moseley did right to arrest the hurry of belief, and impress caution: but that time is passed, and each fair practitioner is bound in duty to determine now respecting this discovery. As to myself, I have inoculated many thousands without ever taking any remuneration whatever for my trouble, and still continue the practice to this day on others and in my own family; and no inducement under the heavens could at this time make me so swerve from the principles of rectitude as to inoculate with the *small-pox.* If the word committing *murder* does sound *harsh,* it is still such in fact, notwithstanding the *licence* which the medical man receives, and should, I think, be thundered into the ear of some few of the faculty. I know *many* of the same way of thinking in this respect with myself.

*Inoculation of the Village of Lowther**.

Lowther is a most pleasant picturesque village, situated two hundred and eighty miles from London, seven miles from Penrith, and a mile from the antient famous mansion of Lowther, and was built by the late earl of Lonsdale, in the Italian taste, is regularly sashed, contiguous, from two to three stories high, each house being of stone, and, without doubt, is the most tasty village in the kingdom. It contains about four hundred inhabitants.

His lordship, observing, with great acumen, the cause of the prosperity of the north of Ireland, after having built in this delightful spot a village, unique of its kind, sufficient to contain five hundred inhabitants, sent over to Ireland for manufacturers of cloth, to set the example of the true welfare of a nation. Here it is all his lordship's linen, as table-cloths of damask, napkins of the same, towels, sheeting, and long-cloth; in short, every article of linen in use have been fabricated, and no other is at present employed either at his lordship's establishment in London or at Lowther. Besides these manufacturers, all his lordship's labourers reside here, rent free, and are allowed a regular stipend both summer and winter, and, however old, are paid equally as when they could exert their youthful strength. It was with pleasure that I witnessed, in the winter, potatoes given as usual, meat, and bread; and when any of the wives are near their time to be brought-to-bed, they send to Lowther for linen, and are allowed beer-caudle during the month. The villagers, indeed, generally lament that there is no public-house throughout the whole place; but his lordship no less regards their temporal than their eternal welfare.

——————————Agricolæ,
O fortunati nimium, sua si bona nôrint! VIRG.

Hence it is that the village of Lowther exhibits what should be the pride of English nobility, a fine healthy industrious peasantry, supported by, and contiguous to, a rich domain.

Let the reader of sensibility contemplate the difference between that pride of nobility which desolates a country to extend a park, and that patriotic spirit which, at a considerable expense, establishes towns and villages for the purposes of manufacture.

Every thing seemed to conspire to render our experiment the most decisive imaginable. His lordship observing with a true patriotic eye, which looks beyond the narrow circle

* From facts decisive in favour of the cow-pox. This inoculation was in the year 1800.

of

of private advantage, considering only the public welfare, had shown himself adverse to partial inoculation*: hence the younger part of the whole village for upwards of twenty years were exempt from the small-pox, and therefore liable to this disease.

As fortune would have it, during the period Rose was under vaccine inoculation from matter obtained by me from Mr. Ring, who has been a most zealous advocate for vaccine inoculation, one of the industrious little villagers, a lad aged nine or ten years, had picked up mushrooms, which at that time were uncommonly abundant, and carried them for sale to Penrith, unknown to his parents, where the small-pox then raged, and had swept off a number of persons. This child took, in consequence, the natural small-pox, and exhibited signs of it, when Rose, æt. 9, the child of his lordship's porter, was in a right state for propagating the vaccine inoculation.

It was now harvest-time in the north both for hay and corn, and there was not to be an idle hand throughout the whole village. No language can express the dismay that was spread from this event. Amidst this universal consternation and dread of the small-pox, seen by groups of old people anxiously conversing of the impending calamity, his lordship ordered the glad tidings of a general inoculation with the *cow-pock* to be proclaimed, the advantages of which were stated, and had been seen in the case of Rose, who had ailed little or nothing, and had but one local pustule, with slight constitutional affection; and the whole assembly were ordered to appear in review at Lowther before his lordship.

Upon going to see the child labouring under the natural small-pox, I found his face greatly tumefied, not a feature to be discerned; blind, covered with pustules from head to foot; the whole face was one smear of blood and gore; and the parlour he lay in being small, the stench was so intolerable, that I was obliged soon to quit the room to hinder myself from being sick. I proposed inoculating the other two children with the small-pox; but the mother was much prejudiced against inoculation, and had rather "trust them to God's will:" hence I foresaw that I should obtain a full completion of my views†.

The

* There is a section in this work, "Whether society at large has benefited by the introduction of the small-pox inoculation?" The answer is in the *negative*.

† *Maturation* appears to be the season when the variolous miasms are emitted

The happy villagers now thronged to his lordship's domain; and it was a most pleasing sight for me to see assembled at Lowther in the steward's room, in the presence of his lordship, so many persons to whom I was about to render the most essential service: at the same time I was enabled to make the most *decisive* experiments respecting a practice, which promised to be an epoch in the annals of medicine; and I flatter myself that the importance of the subject, and the present period of *ungrounded* alarm, will be a sufficient apology for my publishing here the scattered observations I at that time made, and without the smallest view to their publication.

MEMORANDUMS.

1. Mary Bryham, æt. 20, is a good-looking well-grown girl, of a very florid complexion, the daughter of a groom of his lordship's, William Bryham, who has superintended his lordship's stables upwards of forty-eight years. The arm rose finely, pustuled and then scabbed, but there was not the slightest constitutional affection.

Observations on this case.—Having passed through the vaccine disease (as far as regards the essential circumstance, a proper pustule forming itself, and going through its respective stages, which occupies a space of from fifteen to twenty days,) I introduced her to where lay the wretched family in the natural small-pox; one child was hardly recovered, and a second was in a deplorable condition, blind, and at that time dreadfully moaning. I shall never forget the expression of alarm manifested by the girl's countenance, she having never seen this disease before. The blackness had not quite worn off the face of *one*, a *second* was at its height, and a *third* sickening; and if fear increases the pre-disposition to take infection, there was no want of this here*, and with the utmost difficulty I could get

emitted most copiously, the poisonous pus being exposed at that period naked to the air, according to the accurate description of the faithful Sydenham. "Usque ad hunc diem" octavum a primo insultu "pustulæ, quæ faciem obsederant, læves ad tactum fuere atque rubræ, jam verò asperiores evadunt (quod quidem primum est incipientis maturationis indicium) et subalbidæ, paulatim insuper *succum* quendam luteum, colore a favo non abludentem, *evomunt*."

* Besides the horror of the scene, *another cause* might have conſpired. There lives in the same village along with her, Ann Roper, the daughter of her mother's sister, and this girl was so dreadfully ſcarred by the SMALL-POX, that she was rendered, to use the vulgar phrase, a *perfect fright*; she was said before to have been a *bonny lass*, and I might add, that she has from the same cause a speck over her right eye, of which she is blind.

get her to come near these children: but having, after much persuasion, the first surprise being over, consented to let me inoculate her plentifully with the variolous matter in both arms, she afterwards was induced to touch the children labouring under the small-pox with her hands, and catch their breath, but to no purpose; for, having had the cow-pock, she was *unsusceptible of the small-pox, in whatever way attempted to be given.*

2 & 3. Thomas Nicholson, æt. 6, and John, æt. 1, his brother, a child at the breast, passed through this disease, as is common. On the eighth day the accession of fever came on, rather stronger marked than usual, the symptoms of which were heaviness, a want of appetite, disinclination for food, an increase of heat, the sleep at night restless. Sometimes these symptoms, especially with infants, are accompanied with nausea, and actual sickness; but these symptoms in a day or two passed off, and the patient was left in perfect health. There was no eruption in either of the two cases.

Observations.—The first reflection that must naturally strike the reader is, that the child who was in arms, labouring under the cow-pock, did not *communicate* this disease to the mother, who never had had the cow-pock; hence this disease is not contagious: secondly, being next door neighbours to the Smiths, and after the cow-pock had scabbed, being permitted to visit their former playmates, that they resisted the small-pox. Besides this chance, they were each inoculated by me plentifully with the small-pox matter; and not satisfied with this, I had them put *naked into bed* with their neighbour's child, covered with maturated pustules; but it was all to no purpose, they were rendered by the cow-pock *unsusceptible of the small-pox in whatever way attempted to be given.*

4, 5, & 6. John Hutchinson, æt. 9, William, æt. 7, and Thomas, æt. 2, went properly through the several stages of the cow-pock pustule. John and Thomas had an accession of fever on the seventh or eighth day. William ailed nothing.

Observations.—These were next door neighbours to the Smiths, on the right, and being suffered to enter the house of their old playmates after the cow-pock had scabbed, they were exposed to the contagion of the small-pox for hours together; they were also plentifully inoculated by me for the small-pox, but were all three *unsusceptible of that disease.*

7. Thomas Johnson, æt. 13, was inoculated like the rest in the arm. The occupation of this lad was to drive a cart, usually

usually in company with his father, for the earl of Lonsdale; and going to Penrith on the fifth day after inoculation, he drank a pint of strong-beer given him by one Pellet, at Mr. Hutchinson's brewery, and came back that same day with his team, having walked upwards of fifteen miles. In consequence there was an *attempt* towards forming a kind of *eruption*, *one pustule* appearing on the breast, and *another* on the cheek, which actually *scabbed* over, and he passed a restless and feverish night, and continued feverish the next day and night; after which he was able to drive his team and three horses as usual; and being inoculated by me with the small-pox matter, and frequently exposed to the influence of the small-pox in the house of the Smiths, he was found *unsusceptible of that disease*.

Observation.—What would have been the consequence of such imprudence under variolous inoculation as was exhibited in this case, I leave to the conjecture of the sensible reader! The appearance of a couple of pustules, and these maturating, is a very *rare occurrence*; for this disease is almost invariably confined to the inoculated pustule, and most probably arose from his blood being over-heated by the beer and exercise.

8. Maria Johnson, æt. 16, his sister, had the cow-pock without any accompanying fever.

Observation.—She was inoculated twice for the small-pox, and rubbed her hand over Smith's children, and was frequently in the infected house, but was found *unsusceptible of that disease*.

9. William Hodging, æt. 13, was inoculated in both arms; the pustule took, however, only in one. He is carpenter to the earl of Lonsdale, and works with his father in the raft-yard. On the ninth day he had an accession of fever, but not so much as to make him leave off work.

Observations.—This youth lives but two doors from the infected house, was taken by me into this house, and brought so near to the children as to receive their breath, and at *seven* different times was inoculated both for the small-pox, and as many times for the cow-pock; but having had the latter disease, no *proper pustule* rose, performing its *regular stages*, or exciting the least *constitutional affection*; and hence he may be safely declared *unsusceptible of either disease*.

10. Mary Henley*, æt. 14, was inoculated also in both arms.

* This case with others has led me to condemn the common practice of inoculating in both arms, or in more than one place, and will at last have its effect. One point of inoculation is enough.

arms. It took effect in both places, and the pustule on the left arm rose finely, and did extremely well; but that on the right arm got rubbed by some means, formed itself into an *ugly scabby sore,* producing *real pus* under it; and as fast as the scab came away, it formed a larger sore, very deep, and was a very troublesome wound for more than six weeks, the *scab* filling up the place, extending to nearly the size of half-a-crown; and this would have been set down as an untoward case of vaccine inoculation, depending upon *some peculiarity in the constitution,* unless fortunately we had inoculated both arms, and the one arm had done so kindly. She had no fever, or any constitutional affection; was taken into the house where the natural small-pox was, and inoculated then, and several times after, but to no purpose; she was *unsusceptible of the small-pox.*

11. Maria Fry, æt. 7, had one pock, the fever was of one day and night's continuance, and her father described her "as burning like a coal, sick, but not to vomit, and as rambling in her sleep."

Observations.—When she had gone through the cow-pock I made a double experiment; I inoculated her with the small-pox, and at the same time her sister Charlotte, æt. 15, who had had the small-pox when seven years old, and was terribly disfigured by it, with the cow-pock; and, contrary to my expectations, there was *a pustule* formed in Maria Fry's arm, and a general consternation took place among the villagers; but upon examination, there was *no bur of inflammation* round it, no regular *pustular rising*; it *scabbed* on the *fourth day**, and produced *no constitutional disease,* or *any pustules:* the cow-pox in Charlotte Fry died away like a common *scratch.*

It may not be irrelevant to mention here, that Jane Mattinson and Mary Dunn both presented themselves to be inoculated; but from their own account it was more than probable they had had the *small-pox.* The former had nursed a child who died of that disease; it was the child of his lordship's park-keeper. At the same time I inoculated these with the cow-pock, I also inoculated

* In a few instances where a pustule has been formed of either kind, the progress was found to be very different from the true pustule; and this kind, like a seed sown on ground, or in a climate, not congenial, came forward, and soon passed off; whereas the other has its regular stages of rising, falling and scabbing. Those who have the spurious pustules, if I may so call them, have complained of much *itching,* which I have not observed in the other sort; and at the end of ten days the pustule was gone, without leaving behind the usual large and deep scar.

the

the brother of Mattinson, a young man who was dreadfully scarred and marked with the small-pox, and James Broom, who had also the marks of that disease; and these were done with both sorts, but in each instance there was only produced a *slight temporary local irritation,* and *both places* before the *fourth day died away.*

Observation.—It appears, therefore, from these facts, that those who have had the cow-pock are unsusceptible of the small-pox, and *vice versa.*

12. Richard Walker, æt. 24, carpenter, on the ninth day was attacked with a fever, was light-headed, wanted to get out of bed; the next day, the tenth, was enabled to do some work, could not work much, had the fever return at night, after which he ailed nothing, continuing his labour as usual all the while, except on the one day mentioned. Inoculated with both the cow-pock and small-pox, but *neither took effect.*

13. Harriet Fletcher, æt. 18, had only one pustule, and says she was able to follow all her domestic concerns as usual, never being laid up a single day. Inoculated with the small-pox, but was found, like the rest, *unsusceptible of that disease.*

14. John Saunderson, æt. 10, had one pustule and ailed nothing. His brother,

15. Joseph Saunderson, æt. 7, had a fever for two days and nights, was hot and restless, the fever came on on the seventh day. Both were inoculated with the small-pox, but *without effect.*

16. William Patterson, æt. 9, had one pock, also a small one underneath, which came out a few days after the other; feverish two days and nights, the fever commenced on the ninth day. Inoculated with the small-pox, but it took *no effect.*

18. Hannah Mandle, æt. 2, had one pock, never ailed any thing.

19. Mary Falofield, æt. 11, one pock, feverish on the 8th and ninth nights, but played in the interval.

20. John Henley, æt. 16, one pock, never ailed any thing.

21. Hannah M'Cran, æt. 9, one pock, never ailed any thing.

22. Sarah M'Cran, æt. 7, one pock, and another came out an inch below it, which was much smaller, and which went in stages, and scabbed like the other; ailed nothing.

23. Thomas Richardson, æt. 4, one pock, no fever.

A particular observation.—He is terribly scarred in the

 face

face and body, a year before his clothes catching fire, when the child was nearly burnt to death.

General observation.—These six having had no perceptible constitutional affection, they were inoculated again with the cow-pox, but this took *no effect*; also with the small-pox, but they were likewise *proof against both.*

THE CONCLUSION OR INFERENCE.

Fearful that continuing the same account* would only fatigue my readers, I shall therefore just sum up, that *forty-eight*

* The examples of this sort, furnished by my practice as physician to the Mary-le-bone dispensary, for four years, are extremely numerous. I shall mention, however, only a very few strong cases, thinking that more would be needless, and tiresome to the reader.

Three years back I inoculated John King, æt. 3, and Thomas, æt. 1½, children of the publican, who lives in Margaret-street, at the corner of Great Portland-street, with the cow-pock, and they scarcely ailed any thing. Mr. King's niece not long after came out of the country, and on her arrival in town fell ill of the natural small-pox, and had them very full. John King *slept* with her the whole time; they both were with her in the day; and the mother relates, that frequently since they have been in company with children labouring under the small-pox, never wishing them to avoid it. And to complete the *decisiveness* of this fact, I had them both, at two separate times, inoculated for the small-pox; but having had the cow-pock, they were rendered thereby unsusceptible of the small-pox.

I inoculated John, Thomas, and William Plant, who live in Edward-yard, Edward-street, and they had the cow-pock the usual mild way; a fourth child was inoculated with the small-pox, and a plentiful crop of pustules were produced. The children being in the same house, ate, drank, and were constantly together, but no infection took place. I then inoculated these three repeatedly with the small-pox; but they were found each time to be *proof* against that disease.

Elizabeth Restieaux, living at 38, Castle-street, Oxford-market, was inoculated by me three years ago, and had the cow-pock in the usual mild way. A year after this she was in the same house where there were three children who were seized with the natural small-pox in a very bad manner, and she was constantly with them, and has since been taken repeatedly to houses at my instigation in which the small-pox was; and she has also been inoculated by me twice with the small-pox and once with the cow-pock, at different intervals, but without these producing the smallest effect more than a slight scratch from a lancet.

Margaret Pitchet was inoculated by me four years ago. Some months after she had had the cow-pock, a child in the same house, No. 8, Duke's-court, Bow-street, took the natural small-pox, and was covered with pustules from head to foot. These children were together as usual; but no small-pox was communicated; and having inoculated her at least a dozen times since, at different periods, I found her in every instance *proof* against the small-pox.

Mary, Robert, Thomas, and Alexander Routledge, living in St. Ann's-court, were inoculated by me for the cow-pock. Mary was *purposely* sent to

eight inhabitants of the village of Lowther, of different ages, who had never had the small-pox, were inoculated by me for the cow-pock; and having passed through this disease without risk or danger of life, or person, that they were nearly all, at least the majority, inoculated afterwards at *two remote periods for the small-pox*, and *exposed to its infection by being brought into the room where the small-pox was*, but in not a *solitary instance* did any receive *this disease*. Such an escape in such a number cannot possibly be attributed to any peculiarity of constitution; but it must be allowed to the true cause, the *preventive influence* of the *cow-pock*. This law amounts therefore to an absolute certainty, or demonstration; for whence do we form the notion that fire burns the flesh? My personal experience of this circumstance, and traditional report does not approach to half the number of instances as respecting the *preservative power* of the *cow-pock*, nor has indeed any one a more ample or better ground for believing that *cork swims*. To disbelieve *now* the efficacy of the cow-pox, must therefore arise either from IGNORANCE or PREJUDICE; and indeed there are reported to be even *at this time* a few doctors, who do not credit *the thing*: but I flatter myself, this report is unfounded; for an *ignorant doctor* is a *misnomer*; and respecting *vulgar prejudices*, these mental mists will, it is hoped, soon vanish before the clear sunshine of *truth*.

PROGRESS OF THE VACCINE INOCULATION IN THE NORTH.

From such *demonstrative* evidence of the superior advantages of the cow-pock, the countess of Darlington,

to a relation's, whose child had just taken the natural small-pox, and continued there three weeks, but never caught the small-pox, having previously had the cow-pock. A lodger in the same house refusing to have her two children inoculated with the cow-pock at this time, a few weeks after lost both by the natural small-pox.

Mrs. Hutchings, housekeeper of the Rev. Mr. Townsend, author of the "Guide to Health," having come to live in town with her husband, had her child inoculated by me with the cow-pock; with this child in her arms she nursed a friend's child labouring under the natural small-pox, who with difficulty recovered from it; nevertheless her infant did not take the small-pox, having previously had the cow-pock.

The same was the case with Mrs. Britain, No. 3, Pit-street, whose child escaped the small-pox from having had the cow-pock, although two children died of the natural small-pox, at the next house, to which her child was often taken.

Two of my own children, who were inoculated by Dr. Jenner for the cow-pock, and ailed nothing but the pustule on the arm, were both afterwards inoculated by me for the small-pox, and often exposed to it, but without its producing that disease.

daughter to the duchess of Bolton, who is sister to the earl of Lonsdale, had her last child inoculated with the cow-pock, although lord Barnard and four other children of the earl of Darlington had had a mild disease from the small-pox inoculation. Colonel Lowther, member for the county of Westmoreland, who was with his lordship, had a child of his inoculated with the same, although he had seven before inoculated with the small-pox; and colonel Satterthwaite, member for Cockermouth, a borough of his lordship's, being at Lowther, having lately lost a grand-child by small-pox inoculation, was rejoiced to embrace this opportunity, and had vaccine matter from me sent to his son-in-law, Dr. Head. Captain Preston, of Warcop, coming to Lowther, followed the example, mentioning "that the reason why he had not had his child before inoculated with the small-pox, was the fear of bringing this disease into his village." And such indeed was the general conviction of the country-people of the efficacy of the cow-pock, (namely, its power of rendering the constitution unsusceptible of the small-pox, and that it was a disease infinitely milder than the small-pox, never killing, not infectious, and giving little or no trouble,) that the whole country around Lowther came to solicit a participation of the benefits resulting from the cow-pock; and on several days I was engaged in inoculating often to the amount of a hundred and ten* persons,—Mr. Storey, of Penrith, his lordship's apothecary, kindly assisting me in this work of humanity.

It was a most charming sight to behold the finest peasantry in the world assembled at Lowther for the purpose of having themselves, or of giving the cow-pock to their children, to secure them ever after from the horrid ravages of the small-pox; and such was the courage displayed, that out of one hundred and ten persons mentioned above as inoculated in one morning, I do not recollect seeing more than one frightened at the sight of the lancet, nor were the fears of this child communicated to the rest. So

* The number of inoculated persons on one morning *only* was one hundred and ten, from six weeks old to forty-two years of age; and when the question was aksed, whether they would have come in such numbers to have the *small-pox?* there were very few who did not declare, that they disliked the *small-pox*, each assigning different reasons; but the principal objection was, "they had known such and such *die* from the *inoculated* small-pox," and "that they could not *spare the time* to attend upon a sick family;" and several smilingly said, "they could not *afford to pay for it*; nor did a single individual express the smallest distrust of the virtue of the cow-pock, but all received the inoculation both *cheerfully* and *thankfully!*

thronged

thronged were the carts and waggons and horses loaded with the rich treasures of the country, that, as at fairs, there were women who came to Lowther with cakes and fruit, and the turnpike-man desired I would go through his gate toll-free, saying, "he had never had so many people pass his gate before." The number inoculated by me at Lowther amounted in all to above a thousand; and calculating what others have done from my example, I should suppose that the number must have risen since to near twenty thousand.

Sir James Graham, of Netherby, near Long-Town, on the borders of Scotland, being much indisposed, came to the earl of Lonsdale's at his lordship's desire, on purpose for my advice; and having witnessed the good effects of the cow-pock, he took matter back with him to have his nephew (the child of the Rev. Mr. Graham, the rector of Arthuret) inoculated, and that he might extend this blessing to his tenantry. Of the pleasing result of this case I have the satisfaction of laying the following letter before my readers:

"DEAR SIR,

"I have had the pleasure to receive your kind letter. My little boy has had the cow-pock so very favourably, that little or no fever has attended the complaint, if any; it was very trifling on the eleventh night: seven children were inoculated from him yesterday. I am happy to hear lord Lonsdale is better, and hope you will soon restore him to perfect health; I beg my respects to his lordship. My brother and his lady are considerably better from your skilful advice.

"I am, dear sir, &c.

Arthuret, "FERGUS GRAHAM.
Nov. 24, 1800.

P. S. The inflammation on the arm was about the size of a shilling."

I was equally anxious to establish the cow-pock at Carlisle, which is situate but nine miles from Long-Town; and Dr. Heysham, an eminent physician of that city, proposed setting the example by having his own child, only six weeks old, inoculated.

As a more certain means of imparting the cow-pock, I agreed with the parents of one of the villagers, who had the pustule in a proper state, to set out on horseback, for Carlisle, with his child, Mary Brown, a girl only five years old; which was consented to: and immediately upon reaching Carlisle, after a journey of twenty-six miles, nine per-

sons

sons were inoculated from her by Dr. Heysham, of which event the following letter is a document:

"DEAR SIR, Carlisle, Nov. 13, 1800.

"I return you my best thanks for your very obliging letter, and am certain that the inhabitants of this city are under great obligations to you for your kind attention in sending a healthy subject under the action of the cow-pock. Nine children have been already inoculated from her under my inspection, and several more will follow their example to-morrow. As soon as the infection takes place, I shall advertise a general inoculation at our dispensary; by which means I doubt not but the practice will become universal in this part of the country. My little girl was inoculated with your second lancet the moment it arrived, but without effect, and a third time yesterday with one received per favour of Sir James Graham. I shall attend to your P. S. and will recommend to all the surgeons to make use of very clean lancets, and matter taken early in the disease*.

"I am, dear sir, &c.

"JOHN HEYSHAM."

The pleasing result of the first trials at Carlisle will be seen from the following letter:

"DEAR SIR, Carlisle, Dec. 6, 1800.

"Mr. Alderman Richardson left your favour yesterday evening, when I was out of town; and as I understand he means to return to Lowther, either this day or early to-morrow morning, I embrace this opportunity of informing you that all who have been inoculated here where infection took place, since you sent the little girl, have done extremely well. Not one of them was affected with any considerable fever, or any kind of sickness to excite the smallest uneasiness.

"With respect to my own child we have been rather unlucky, as she has not received the infection though inoculated three times with the dry matter you were so kind as to send. And since we received the recent matter we have been under the disagreeable necessity of changing her nurse no less than twice, and at present, on account of an indisposition common to children, must postpone the inoculation.

"I have the honour to be, &c.

"JOHN HEYSHAM."

* This P. S. alludes to the power of rust in destroying the specific virtue of the cow-pock matter, and producing, in consequence, the *spurious* instead of the *true* pustule; also to the cow-pock pustule *sometimes* losing its specific virtue after the ninth or tenth day.

Upon the return of the little child, after this expedition, I was careful in observing the effects of so long a journey, at this season of the year; and I remarked with pleasure that the fever had been slight, but *two pustules* came out on the face, which completely maturated, and scabbed. Dr. Heysham generously discharged all the father's expenses at Carlisle; Mrs. Graham at Low-House, in the neighbourhood, who had her child vaccinated, gave him ten and sixpence; and Dr. Blamire, who took some vaccine matter from the child, gave the father a crown; and he also received many other presents, which he very honestly mentioned, refusing what I had agreed to pay him; but I insisted upon fulfilling the terms of our original agreement.

The two following letters will show my endeavour to establish the cow-pock at Whitehaven:

"SIR, Whitehaven, Oct. 25th, 1800.

"I delivered your observations, relating to the cow-pox, to Dr. Dixon, who desires me to say that he thinks himself highly obliged to you, and requests you will send him a little of the matter for inoculation, with proper directions how to use it, thinking it would be the means of saving a great number of lives here*.

"I am, sir, &c.

"JOHN BOWNESS."

Dr. Thornton,
Lowther.

"SIR, Whitehaven, Nov. 21st, 1800.

"Receiving a letter from my father last night, stating that you wished to hear how my brother came on after his inoculation, enables me to embrace the opportunity of returning my grateful thanks for introducing the cow-pock to my brother and myself, who have both got through the same exceedingly well. I have inoculated several children at Whitehaven and Workington; likewise have furnished several doctors with matter to do the same. On the 22d instant I shall have to inoculate near twenty of his lordship's work-people's children.

"I remain, &c.

"WILLIAM BRYHAM †."

Dr. Thornton,
Lowther.

* Dr. Dixon, Dr. Crostwaite, and Mr. Hamilton, have since introduced the vaccine inoculation into the Whitehaven dispensary, and have inoculated a great many.

† William Bryham superintends lord Lonsdale's collieries, and since this period has inoculated above five hundred; his sister's case is recorded, being among the first inoculated in the village of Lowther.

Lancaster

Lancaster was not forgot, as the following letter will evince:

"DEAR SIR, Lancaster, Dec. 10th, 1800.

"I have this evening received from Mrs. Dilworth (Mr. Yarker's daughter) a little vaccine matter, for which I find I am indebted to you, and for which accept my sincere thanks. I have found great difficulty in introducing the new inoculation here; and had it not been for a sensible and intelligent lady, Lancaster would not yet have witnessed its introduction. Since then I have inoculated several, perfectly to my satisfaction; and the other day I made proposals to my friend Mr. Baxendale, who is surgeon to the Lancaster dispensary along with myself, to inoculate the poor in this town and its vicinity, gratis. With pleasure I inform you it met with his approbation, and with that of Dr. Campbell, and in a few days we begin the business.

"I am, dear sir, &c.

"J. A. Brathwaite."

Nor was Appleby forgot, as the following letter will show:

"DEAR SIR, Appleby, Dec. 17th, 1800.

"This day week I inoculated fifteen with fluid cow-pox matter, all of whom, excepting one or two (which are dubious), have taken the infection, and the pustule looks charmingly. The prejudices of the common people against the operation are sinking to nothing; and I am fully persuaded, that in a very little time the inoculation will become general. I will not fail to transmit to you a regular account of those under my care.

"I remain, dear sir, &c.

"John Bushby."

Nor was even Ulverstone omitted by me.

"DEAR SIR,

"With the lancet you last sent me I inoculated Rigge, but am much afraid, from the appearance of the incisions, or rather punctures, not with the success which has attended my other operations in this new and excellent practice. I have here matter taken from the arms of some of my patients; but, from a *prejudice* which you will easily allow for, his friends here will not allow the disease to be produced in him by any other means than such as originates from you *directly*. I must, therefore, trouble you to send me a little fresh matter for him as soon as convenient. In send-

ing small-pox matter to a distance, I have found it very certainly sent by having two small square pieces of glass, one surface of each being besmeared with the matter, applied together, and tied by a piece of thread.

"I have already inoculated between twenty and thirty of different ages, from matter you *first* sent, and they have had little or no fever or any observable complaint, save the local inflammation of the punctured parts; except in one instance, a daughter of Mr. Sandy's of Grathwaite-Hall, who became feverish the fifth day after being inoculated, and had three pustules upon her face, which were filled with a much more transparent fluid than small-pox generally contains, and these literally scabbed like the inoculated pustule on the arm.

"You will accept my best thanks for your kind attention, and believe me, I am, dear sir, &c.

Ulverstone,
Dec. 1, 1800.

"WILLIAM HARRISON."

I could also mention Penrith, Kendal, Temple-Sowerby, and many other towns about Lowther, in which I introduced the vaccine inoculation: but am fearful it would too much trespass on the patience of my readers. I shall, therefore, hasten to the pleasing contemplation of having, I think, been instrumental by this means in extirpating, for the present, the small-pox from this distant part of England: for, having requested, a year after my inoculation of the village of Lowther, that Mr. Storey would re-inoculate these villagers with small-pox matter, I received from him the following letter:

"DEAR SIR, Penrith, Nov. 7th, 1801.

"I received your favour, and would with pleasure comply with your request, if I could get any matter for inoculation. I have sent to Carlisle, Keswick, Appleby, &c. and I am well informed *that there is no small-pox in this country at present, owing to your inoculation with the cow-pox.* I first went, as you wished, to Lowther, to acquaint lord Lonsdale with the contents of your letter; and his lordship says, he has not the least objection to the children in the village being inoculated with the small-pox matter; which would be directly done, provided I could get the matter, which at present I cannot; but whenever I am able to procure any, you may rest assured that I will with much pleasure comply with your request; and

"I have the honour to remain, &c.

"RICHARD STOREY."

Hence

Hence I had occasion to send down to Penrith the small-pox matter between two pieces of glass for Mr. Storey, to re-inoculate the inhabitants of Lowther village, and his report was as follows:

"DEAR SIR, Penrith, Nov. 20th, 1801.

"The glasses with the small-pox matter arrived safe, and with considerable pleasure I set about re-inoculating those persons who the last year had been inoculated by you with the cow-pock in the village of Lowther; and I remarked, with much satisfaction, that I found none whom I inoculated to take the small-pox, the places of insertion of the matter in a few days dying away. This makes the experiment at Lowther *decisive**. It afforded much pleasure to his lordship, who desires to be kindly remembered to you; and wishing you, sir, all the rewards your great exertions for the good of mankind, and advancement of science, so justly merit,

"I have the honour to be, &c.

"RICHARD STOREY."

After such conclusive evidence in favour of the cow-pock, little more appears necessary to be urged, had not some seemingly contrary facts occurred about *Portsmouth* and in *London*, tending to raise a suspicion that the cow-pock was not in every instance a preservative against the small-pox. Of these cases in London, some have fallen to my lot to notice; and they arose from mistakes respecting the nature of varicella, or the swine- or chicken-pox. Lately two cases have appeared in Fulwood's Rents, where there prevailed a very general belief among the faculty that these were genuine cases of small-pox after vaccination. That this was the fact, Dr. Pearson put the matter to the test of experiment, and produced thereby the true small-pox; and two of his patients were afterwards tried by him with variolous matter, and with cow-pock matter by me; both of which *were resisted*. I am not, however, without suspicion; but I declare my opinion, with extreme diffidence, that these two cases were, nevertheless, cases of varicella †, whose pustules were many of them contaminated with variolous

* I propose sending down matter this year, 1804, and will inform the philosophic world of the result.

† This I offer only as a *conjecture*. I propose, if permitted, inoculating Ann and Mary Hodges with the swine-pox: and this will ascertain this point. Mr. Pearson, surgeon, had his children so inoculated, and with success.

matter. My reasons are as follow:—Ann Hodges, æt. 5, when a year old was vaccinated at the Small-Pox Hospital. She went, it may be supposed *, properly through this disease. That she was rendered thereby *secure* from any attack of the small-pox, we have the following *proofs*: As soon as the disease was passed, she was purposely taken throughout every ward in the Small-Pox Hospital, and to the bed-side of a patient in an advanced stage of that horrible disease, but *without effect*. Two years after that, a lodger in the house, of the name of Sewell, had two children inoculated for the small-pox; and they had a full crop of pustules, and she was constantly with them, yet was *proof against the small-pox*. At the period of two years and a half, Mrs. Walker, another lodger, had her child inoculated with the small-pox, who had a plentiful eruption; and, as before, she was constantly with this child, being at that period *secure*: and six weeks back, a child over the way, named Butler, took it naturally, and was shockingly bad. Ann Hodges used to hang over this child, rock it, and remain for hours in the room with it; but all this while was *secure*; as was her sister Mary, also *vaccinated*, who had the cow-pock only two years back. So *frequent exposure*, and in *that degree*, in *two* instances, not to mention *casual rencounters*, seemed to augur future security. All at once, however, the charm †, if vaccination can be called such, ceased with both children, and on the 29th of Aug. 1804, Ann became feverish, and although but a very few pustules appeared, they were

* Dr. Jenner has insisted, that although matter may give the vaccine disease even until the 17th day, yet, that as the pustule after the 10th day sometimes degenerates, and common inefficacious pus is then only to be found in the pustule, producing a *spurious pustule*,—hence his golden rule is—" never to take matter after the tenth day." This rule has been neglected by inoculators, and matter taken in all stages of the pustule. Whether this was the case here, is uncertain; but the escar shows that the inoculation took proper effect; and the parent mentions that the arm was so bad that a poultice was talked of, and it remained so for a month.

† Posterity will be surprised that the doctrine should ever have been maintained and published, and by medical gentlemen, that the cow-pock only secured *for a time*. It was limited at first to *two*, afterwards to *three*, and then to *four* years. Three children of Mr. Henry Jenner, inoculated *five* years ago, have since been repeatedly inoculated with variolous matter, and exposed to the infection of the natural small-pox, in its worst form, every year up to the present time, without catching the disease. Pead, vaccinated by Dr. Jenner more than *six* years, and Phipps, his first patient, vaccinated by him more than *eight* years ago, have been frequently put to the same tests with impunity. In the spring of the present year they were inoculated for the small-pox with matter in the most active state; but they resisted infection.

ushered

ushered in by much fever: these contained but *little matter*, were all distinct, scabbed on the seventh or eighth day, wholly disappeared in four days after, without leaving any pitting: and the mother says "not one was *flat on the top*, or had *jagged edges*; but were all *round at the base*, and *pointed above**."

Four out of this little court had died† of the natural confluent small-pox; and one of these, but the day before Ann was taken ill, was in the room playing with this child. I venture it, with much diffidence, as an opinion, that Ann Hodges had the swine-pox, and on an abraded cuticle matter was ingrafted taken by the hands from the small-pox patient, and a *local* small-pox produced, with the *constitutional* fever of varicella probably increased. In her sister Mary, with whom the charm was broken two years sooner than the other,

* The pustule of the chicken-pox or swine-pox, which are one and the same disease, differs from the small-pox to the observant eye, as one seed differs from another, yet resembling. In botany I should say the one was acuminate and wrinkled, and the other compresso-plane, and smooth. In other words, the swine-pox pustule is elevated, and puckered, and therefore rough; and the small-pox flat, and usually indented in the middle. The hardened and jagged base also discovers the small-pox pustule.

† Mrs. Hodges mentions observing herself *four* funerals from this court: perhaps many more were the victims of a disease that might with great facility be banished the earth. The disappearance of the small-pox from so many towns in the north of England, from the cow-pock inoculation, must give the most heart-felt satisfaction to every mind endowed with sensibility, and, as being an epitome of the greater conquest, namely, the extirpation throughout the globe of the small-pox, in our humble opinion, merits to be recorded as the *harbinger* of that effulgent day when the benign radiance of the cow-pock, like the sun, will extend its glorious influence throughout every clime. Already it has been partially received in all the civilized countries of the habitable globe, and promises ere long to realize the just expectations of its warmest advocates, by being generally adopted from the judicious and proper interference of the legislative powers.—When the small-pox was first introduced into Otaheite, and the destruction was so great as to threaten the entire subversion of the state, these ignorant savages formed laws by which they stopped the progress of the calamity.—How much more reason have we then to expect the subjugation of this formidable enemy of the human race, in a more enlightened period and from more enlightened statesmen, an easier mean being now in our power, than restrictive laws to prevent infection, namely, the cow-pock inoculation, which, perhaps, might be enacted in each state; for *no one is born for himself alone*, each being placed with reference to the community! And thus there being no longer left any fewel for the small-pox to blaze up into a great national calamity, hence the delightful prospect of the annihilation of the small-pox throughout the whole habitable globe. The Nabobs in India having commanded general vaccination, *millions* have obeyed, and the *small-pox* has already *disappeared* in the *East*.

 I observed

I observed three distinct kinds of scabs*, and her history deserves also consideration. On the 13th of Sept. MARY HODGES fell ill. Before that she had been with her sister, and was daily playing with the children in the court. The fever and delirium was great; and Mr. Wachsel, apothecary to the Small-Pox Hospital, saw the patient, as the eruption was appearing, on the Tuesday and Wednesday; and when he came on the Tuesday following he said "he never was so *amazed* as to find the child alive, and to observe such a *mild progress* of the disease." He then told Mr. Morgan, "that he now somewhat altered his opinion about this being *certainly* small-pox." Every one will call, with me, to mind

* The occasion of my seeing these children in Fulwood's Rents arose from the following letter:

"*Central House, Salisbury Square*; 24, ix, 1804.

"John Walker, resident inoculator, feels it incumbent upon him to make the following communication to all the medical gentlemen of the Royal Jennerian Society:

"In Fulwood's Rents, Holborn, there have lately fallen some victims to the small-pox; others have recovered. On two children, in the same family, who had been inoculated for the cow-pox above two years ago, eruptions, supposed to be the small-pox, have appeared. These, in the elder, have passed away two weeks ago, and scarcely left *a shade* or a *mark* behind; on the younger a general eruption appeared on the 15th instant, and is now pretty *generally* pronounced to be small-pox by a very great number who have visited it. Two children have been inoculated from this subject; one on the 21st, in the evening; the other on the 23d, in the morning.

"Wigham and Morgan, 63, Holborn, inform me that they expect these two children at their house, together with the two other children, on Wednesday, the 26th instant, at 12 o'clock, where they will be glad of the company of all medical gentlemen who may think it sufficiently interesting to attend. J. W."

In consequence I went to see the last child, and it was in the state of scab. These struck me upon examination to be of three sorts; the one the chicken-pox scab; scab of the eruption from heat, common in the West Indies, and known by the name *eczema solare*, the product of heat; and a third sort, from the contamination of the small-pox virus. (Vide plates to my work entitled "Facts decisive.") These differences I showed to Mr. Wright, surgeon, and others. When the scabs wore off, the skin was *not discoloured* as in the *genuine* small-pox. All the pittings nearly were *circular*, not *jagged-edged*, or the skin underneath *fair* and *glossy*. The scabs mostly were a light brown colour. Dr. John Walker, vaccine inoculator of the Central Station; Dr. Hooper, resident physician to the Marylebone Infirmary and lecturer on the practice of physic, equally distinguished for accurate knowledge as experience; Mr. Hurlock, apothecary,—all declared "that they would not allow the present to be an instance of the *genuine* small-pox," and all agreed "it was a *very small* sort." By way of argument presently, I have even granted these to be *genuine cases* of small-pox; and we shall see how far these, even then, are *objections* to vaccination.

the extraordinary hot weather of this month. On the Sunday* the parents confess that the leg of mutton at the fire was so putrid as to be obliged to be thrown away: and this also happened with my meat, and was common throughout London. I say then, that it is almost incredible under these circumstances, labouring under an aggravated fever, that 20,000 pustules should be all *coherent*, and none *confluent*; or that this child, worn down by hooping-cough, should, under such circumstances, have surmounted this disease if it were the *genuine* small-pox. As the small-pox effluvia render the cow-pock eruptive, and not a single local pustule; and as the cow-pock with the itch becomes pustular and general, so may the small-pox matter modify the swine- or chicken-pox and eczema; and the same might have happened whether the patient had previously received the vaccine or variolous inoculation. That a *local* small-pox may be produced, almost every day's experience might determine; and that a disease from this cause *resembling* small-pox should create, even if there were no varicella, sometimes a *constitutional* affection, is also known. But in all such cases certainly there is a *something* that marks the distinction of the local and genuine small-pox; and, as Dr. Woodville informed me, Mr. Goldson's cases "were not small-pox;" but it must be allowed he describes a disease *somewhat similar* to the genuine small-pox.

Mr. Fewster, of Thornbury, communicated to Dr. Jenner the following case:—" A child, who was inoculated for the small-pox, had a plentiful eruption on the face. His nurse-maid, who had the disorder many years before, and was much pitted with it, used to let him sleep on her left arm; so that his face was in contact with her left cheek.

" The consequence was, that in little more than a week

* I was led more particularly to notice the weather at this time, being summoned to attend a coroner's inquest, respecting a child supposed to have been poisoned by its mother on the Friday, from the quick putridity of the body on the Sunday, and employed on the Monday the knife, to clear up the fact, with no small danger to myself. The charge was groundless. It died by drinking boiling tea out of a tea-pot. Thursday, Sept. 12th, the thermometer in a north aspect stood as high as 81°. On Friday and Saturday it was the same. On Sunday, from one till two, it stood as high as 83°, and by ten minutes after two (a most remarkable phænomenon) was decidedly at 84·7° (eighty-four degrees seven tenths). Here it became stationary, till 20 minutes after two, when it began to fall, and gradually descended to 80°. Now the usual summer's heat, even of July and August, seldom exceeds 80° of Fahrenheit's thermometer; and this will readily account for the contaminated varicella and eczema eruption in this child being so general and abundant. At this period I noticed several very bad cases of both varicella and eczema solare.

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a *considerable* eruption appeared on this cheek, which went on to *maturation*. Three days before the appearance of the eruption she had slight chilly fits, pain in her head and limbs, and some degree of fever.

"On the second day of the eruption she complained of a slight sore throat. Mr. Fewster seems doubtful whether these symptoms were occasioned by this occurrence of local small-pox; but, I apprehend, without reason. I have related, says the indefatigable Mr. Ring, in my Treatise on the Cow-Pox, a case of Mrs. Fraise, now living at Southampton, who had several small-pocks on her face and her breast from the same cause, accompanied with more violent fever and pain in the head than what sometimes attend the disorder when it occurs the first time.

"With matter from the nurse-maid, Mr. Fewster inoculated two other children, and produced the perfect small-pox. The late Mr. Kite, of Gravesend, excited a variolous pustule on his own arm, and sent some of the matter to Chatham barracks, which proved effective. A late professor at Edinburgh used to mention, "that an itinerant inoculator practised this method on himself, for the sake of preserving a constant supply of variolous matter."

"A gentleman of my acquaintance," says Dr. Buchan, "who practised inoculation very extensively, had taken as much matter from a patient in the small-pox as was sufficient to inoculate forty or fifty others. For this he had been obliged to open a good many pustules; and while his hands were daubed with the matter, happening to cut one of his fingers, he immediately put his thumb on it to keep in the blood, and held it there for some time till a rag was got, with which he bound up the wound, and took no further notice of it.

"About eight days after, he began to feel an unusual weariness upon the least motion, and complained of a dull pain of the head and loins; with a listlessness, and want of appetite. On the ninth or tenth, in the evening, he complained of sickness; and was actually seized with a syncope, or fainting fit.

"On the next morning an eruption appeared, which was pretty universal, but thickest upon the limbs. This had, indeed, more the appearance of *a rash* than of small-pox; but as it appeared about the same time after receiving the wound, that the small-pox generally do after inoculation; as the symptoms, previous to the eruption, were the same with those which usually precede the eruption of the small-pox; and as the eruption *continued* upon the skin about

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the same number of days that the small-pox generally do, there seemed to be a good deal of reason to conclude that the disease had proceeded from a quantity of the variolous matter which had been introduced into the blood by the wound.

"This patient, indeed, recovered by the help of medicine, and a good constitution. This gentleman had had both the small-pox and measles, in the natural way, many years before.

"Several other cases have occurred in my practice, where the constitution seemed to suffer from variolous matter introduced into the blood, without creating *what could properly be called the small-pox.*"

Hence we learn, that even the producing the *genuine* small-pox from the cases in Fulwood's Rents, is no certain criterion of these children having had the true, genuine small-pox. And should my *hypothesis* be allowed, the same might have occurred even after variolous inoculation.

But, to bring over our adversaries, it may be prudent to allow, that in this instance, and in a very few others, the *genuine* small-pox has actually occurred after vaccination. But such, it must be allowed, are rare events. Persons are also said to have received the small-pox *twice*. Yet this is held as no argument against inoculation. Such is, indeed, accounted only a very extraordinary circumstance. When I was lecturing at Guy's Hospital, happening to take with me some ipecacuanha root, the attendant, only from carrying this into the lecture-room, instantly perceived what was in the paper, and was seized with the disagreeable effects of shortness of breath and sense of suffocation,—an *idiosyncrasy*, which I have seen from cheese, or the sight of a cat: but upon the birth of a child, I should no more fear its being convulsed with the effluvia of ipecacuanha, or ready to faint from the smell of cheese, or become furious at the sight of a cat, than I should fear its having the *small-pox* after *proper vaccination*. The facts in the opposite scale are so numerous, that such an event is *next* to a *miracle*; and if vaccination goes on as it has begun, and merits, there would be no longer *small-pox* to make the experiment; and such an event actually happening, is only an argument for the advocates of cow-pox to insist the more, and urge on *general* vaccination.

I have troubled you, sir, with these observations, hoping that such events as the above will not retard the great cause of vaccination; for "as one swallow makes no summer," so

so two, or twenty such instances, scarce form the shadow of a just objection against this grand improvement in the art of preservation.

I have the honour to remain, dear sir,
Your obliged and faithful friend,
ROBERT JOHN THORNTON.

VI. *Comparison of the Small-Pox and Cow-Pock Inoculation.* *By* CHARLES BRANDON TRYE, *Esq. Senior Surgeon to the County Hospital, Gloucester.*

SIR,

WHEN Dr. Jenner first introduced vaccine inoculation, I declined adopting it. Inoculation with the small-pox I had long practised without a single loss; I had also fixed opinions in physiology which militated against what was advanced by himself and his friends. In process of time, however, such a mass of clear, undisputed, *decisive* evidence came forward in support of the newly discovered preservative, as to be irresistible to a mind not *hardened* beyond the *susceptibility* of *conviction*; and, consequently, whatever might have been my previous notions, or my habits of thinking, I could no longer persist in the use of *variolous matter*.

I will not say that my own practice in inoculating with cow-pox matter has been so considerable as that of many others, or that I have made a variety of experiments with a view to understand or explain any of the phænomena of the disease; but I will say that in the small-pox, both natural and inoculated, my experience has been ample; and from that experience alone, I was enabled to compare the merits of small-pox inoculation with those ascribed to the Jennerian practice. From my own experience, then, I can assert, first, that whatever has been said against the sufficiency of cow-pock matter as a security against variolous infection, may be also said with truth against small-pox matter, as a similar security. From my own experience I can, secondly, assert, that the subsequent ill effects which have been said to follow cow-pox, have, in a ten-fold greater degree, followed small-pox. And lastly, from my own knowledge, I can assert (and who of long standing in the profession cannot do the same?) that many instances of mortality have happened in small-pox inoculation, whilst amongst

amongst all which has been said not a single example appears of death from cow-pock.

In behalf of my first assertion, I can recollect numerous facts; but as I write for the public, and on a most important subject, I will state nothing in support of that assertion, which shall rest solely upon my own credibility or memory; I will therefore confine myself to the three following cases:

Mr. John Phillpotts, of this city, well known and esteemed in his profession of the law, was inoculated with the small-pox in his infancy, together with an elder sister, by their father, with the same matter, at the same time, and both were nursed by their mother, and two persons accustomed to small-pox, of good judgment, and now living. The young lady had the disease to an alarming virulence; the boy's arm inflamed, he was indisposed, and had four or five eruptions on different parts of his body; and Mrs. Phillpotts says, they appeared to her to go on after the manner of other small-pox pustules. In his twenty-first year I was desired to visit him, as being ill with some eruptive fever. He had spots just appearing in different parts of his body; the next time I saw him, nothing but the positive assertion of himself and his friends, that he had had the small-pox, could have made me doubt that they were variolous. On the following day that doubt was entirely removed. He had a plentiful crop of pustules of the distinct kind, which went regularly through their stages of suppuration and scabbing.

In September 1794, I inoculated a daughter of Mr. John Rudhall, of this city, with matter which I had taken myself from a variolous subject. The child's arm inflamed, she was indisposed, and had a few eruptions which did not suppurate. About twelve months after, I inoculated her again, and she had then the distinct small-pox, with all its usual circumstances.

Mr. Cooke, an eminent apothecary of this city, desired me to see a patient who had some years before been inoculated by a practitioner of respectability and experience for the small-pox, together with ten others, in the gentleman's own small-pox house. The patient supposed that he then received and went through the disease, and the inoculator assured him of it. When we visited him he was then blind with small-pox, which went through its usual stages.

In support of my second assertion, I need not stake my own credibility at all. My experience can only coincide with the testimonies already before the public, of the small-

pox

pox rousing up scrophula in all its malignant varieties, and being followed by phlegmons, ophthalmias, &c.; while nothing beyond cutaneous eruptions has, to the best of my recollection, been imputed to the cow-pox.

But as to my third assertion, its truth is so universally known, that all proof is unnecessary.

I shall go then to the inferences to be drawn from what has been premised. From the cases supporting the first assertion, it appears, first, either that some individuals may receive the small-pox infection twice; or else, that the patient may be infected to a certain degree with variolous matter, but not so as to make an indelible impression on the constitution. In either case, their inoculation with the small-pox has no advantage, as a protecting security, over the cow-pox. Let it be said that the practitioner who inoculated the patient supposed to be infected a second time, was, in the first instance, either inattentive or deceived by doubtful appearances; or that the first time his patient was not inoculated with real small-pox matter, or with small-pox matter in a proper state. To the first supposition it must be answered, that in the general practice of cow-pox inoculation, it is not to be believed that operators will be more sagacious, more discriminating, or more attentive than their predecessors have been in small-pox inoculation; and to the second, that similar errors are just as likely to prevail in vaccine inoculation: so that the conclusion must be, either that there are individuals in whom the susceptibility of the small-pox is not destroyed by a well conducted process either of the cow-pox or small-pox inoculation; or that, in the instances when either the one or the other failed to secure the individual against future small-pox, the process did not go so far as to make the proper impression on the constitution: or lastly, that in the inoculation improper matter must have been used; which, however, could not have been the case in the two first examples given above, it proving my first assertion.

Three instances have been brought forward amidst the voluminous writings for and against the cow-pox inoculation, where it failed of securing the patient against small-pox; two by Mr. Goldson, of Portsmouth, and one in the London papers of the beginning of this month. Whether the patients were inoculated with genuine cow-pox matter or not, I will not inquire; I will admit their weakening our confidence in vaccination to a certain degree. But these three failures, amid the collected experience of the profession in general, are here met by the experience of a single individual

individual in a provincial town, with an equal number of cases, equally weakening our confidence in small-pox inoculation. In this respect, then, let the two inoculations be supposed to stand upon equal grounds. But let the consequences of the one be weighed against those of the other, and the scale of vaccination must incalculably preponderate. In immediate danger to the individual, in remote mischief to his constitution, the cow-pox has infinitely the advantage. To this let us add, that while with the cow-pox the practitioner, at the worst, injures no one except his patient, with the small-pox he may deal misery and destruction amongst his neighbours far beyond the limits of his operating; that in the one he is continually risking the dissemination of a loathsome and mortal disease, while in the other he is conducing to the extermination of that pestilence from among mankind. Let us then turn to common sense, and ask her which she would prefer.

Gloucester, October 6, 1804.

CHARLES BRANDON TRYE.

VII. *Memoir on Nickel.* By C. THENARD *.

THOUGH nickel was scarcely known fifty years ago, it has already been the object of a great many researches; and yet, by a striking contrast, there is no substance, perhaps, which has given rise to so many discussions, and respecting which chemists have so much differed. Some, at the head of whom we ought to place Cronstedt, to whom the discovery of it is due; and Bergman, who first began to study it with care, considered it as a metal of a peculiar nature. Others, who did not attend enough to experiment, and who were seduced by its magnetic properties, did not hesitate to believe it to be iron more or less pure, or more or less altered. The former, suffering themselves to be deceived, in particular, by the blue solution of its oxides in ammonia, have confounded it with copper. The latter, too confident in slight or superficial researches, have seen in its ore only the arsenic and the cobalt, with which it is almost always accompanied, and have taken it for an alloy of these two metals. Opinions so different and so singular could not but disappear with time. The interest of the science required it; and it was a necessary consequence of the products of mineral analysis, formerly uncertain in its progress,

* From the *Annales de Chimie*, No. 149.

and

and consequently in its results, but at present carried to its utmost degree of perfection, and leading into error those only who are unacquainted with its resources. But all doubts are removed in regard to the existence of nickel, if it be incontestably proved by numerous exact and authentic experiments. The case is not the same with its magnetic property, in which it participates, or seems to participate, with iron. If several chemists, along with Bergman, ascribe to it this property, others contest it. It is still therefore a question, of which we have not a definitive solution, to know whether nickel is really susceptible of attraction; especially as it is not yet certain whether it was ever obtained in the state of its greatest purity. The chemical art, indeed, does not possess the means of separating it from cobalt. Those, even, employed for separating it from arsenic are liable to objection, and a rigorous analysis might perhaps excite doubts in regard to those used for separating it from iron. The problem to be solved, and which forms the subject of this memoir, consequently is,—to separate nickel exactly from all the matters which alter it, and particularly from arsenic, iron, and cobalt. I mention these three metals, because they are those which may take from or communicate to it the magnetic properties.

The nickel ore which I treated had been already fused several times; all the earthy matters, and a part of the arsenic and sulphur, had therefore been separated from it. Different trials, which it is needless here to repeat, proved to me that it was composed of nickel, iron, cobalt, bismuth, arsenic, and sulphur. The following is the method of analysis which I followed;

Experiment I.

Having reduced the ore to powder, I roasted it in a roasting-pot until no more arsenical vapours were disengaged. When the odour of garlic was no longer sensible, notwithstanding the violence of a fire long maintained, I put the ore thus roasted and cold into a matrass with a sufficient quantity of nitric acid. The action of the acid favoured by heat became so strong, that a most violent effervescence took place; the vessel was filled with thick red vapours; the solution was almost instantaneous but incomplete, and there remained about a sixth part of the matter employed. This residuum, when separated by the filter, was washed and carefully examined. It was of a white and slightly greenish colour, without savour, insoluble in water and nitric acid, but soluble in muriatic acid, and was precipitated

 black

black from this solution by sulphurated hydrogen and by water in white flakes, which the nitric acid could then dissolve; and with which they gave by evaporation crystals that could readily be distinguished to be nitrate of bismuth. This substance, therefore, was oxide of bismuth, united to an acid which rendered it proof against the common solvents. I presumed that it might be arsenic acid; and indeed my conjectures were confirmed by ulterior trials. Arseniate of bismuth, made in a direct manner, exhibits exactly the same phænomena.

Experiment II.

The liquor of the first experiment, arising from the action of the nitric acid on the roasted ore, and which was of a beautiful green colour, was evaporated, and then diluted with water to precipitate the bismuth which might be found in it. There was no appearance of its being turbid. The whole bismuth, therefore, had been separated by the arsenic acid. It contained copper. Iron immersed in it immediately detected its presence. Having added sulphurated hydrogen, this metal alone was precipitated in the state of hydrogenated sulphuret, under the form of flakes, of a chestnut-brown colour. It was but little in quantity in the ore, and made at most the 1-50th part of it.

Experiment III.

The copper having by these means been totally precipitated from the nitric solution, since it no longer coloured iron, I supersaturated it with caustic potash in order to obtain the oxides pure, and to take from them the arsenic acid which they might retain; but as this method was not attended with complete success, I was obliged to have recourse to another. The one I preferred was as follows:— I again effected a solution of the oxides in nitric acid, and poured into them an excess of hydro-sulphuret of potash. The decomposition was complete: the arsenic acid remained in the liquor combined with the potash, while the oxides were deposited in combination with sulphur and sulphurated hydrogen in the state of hydrogenated sulphuret, and under the form of black flakes. This method of separating the arsenic is so sure, that it induced me to propose it for determining the quantity of that metal in any ore whatever. I employed it with much success in the treatment of arsenical ore of cobalt. I separated from it all the cobalt and arsenic: by treating only with nitric acid and alkalies, the greater part of these two metals remain united together in the

the state of arseniate. This process to be practicable requires only a rigorous analysis of the arsenic acid, and of an insoluble arseniate, such for example as that of lead. I made the first by burning 100 parts of arsenic by nitric acid. I found that the arsenic acid contained in 100 parts, 64 of arsenic and 36 of oxygen; so that it contains only 10·24 more of oxygen than the arsenious acid, since 100 parts of the latter require only 16 of oxygen to become arsenic acid. One thing singular is, that these 100 parts of arsenious acid require at least triple the time as 100 parts of arsenic to be completely acidified. I analysed the arseniate of lead by saturating with ammonia 100 parts of very dry arsenic acid, and precipitating it by acetite of lead. I obtained 380 parts of arseniate of lead, which, dissolved in nitric acid and precipitated by sulphate of soda, gave me 256 parts of sulphate of lead. The liquor remained uncoloured by the sulphurated hydrogen; it contained no more lead; whence it follows, almost rigorously, that in arseniate of lead the ratio of the arsenic acid to the oxide of lead is as 5 to 9.

Experiment IV.

The oxides of the last experiment, being precipitated by the hydro-sulphuret of potash, were introduced into a matrass with the nitric acid. The solution was rapid, and accompanied with a great disengagement of nitrous acid, which caused the matter to swell up considerably: it was of a still more beautiful green colour, especially as in the liquor of the first experiment there were remarked flakes of sulphur which were separated by the filter, and it was then decomposed by potash. The oxides, to the number of three, nickel, cobalt, and iron, were precipitated. Being washed in a large quantity of water, the principal object was to separate them exactly. I knew by my own experiments that black oxide of cobalt was not sensibly soluble in ammonia; but I did not know how to reduce the blue oxide to that state of oxidation. I tried for this purpose several means. Desiccation in the air, by the help of a gentle heat and a renewal of the surfaces to favour the absorption of oxygen, gave me a result not very satisfactory. I did not obtain the whole of the black oxide, some part of it having dissolved in the ammonia. The use of oxygenated muriatic acid was not more successful: it made the oxide, indeed, pass immediately to the maximum of oxidation, but it retained a part in solution. Knowing with what facility oxygenated muriatic acid saturated with lime gives up its oxygen, I conceived an idea that it might succeed; and, indeed, scarcely

scarcely is it united with the blue oxide of cobalt, especially if recently precipitated, when it becomes deoxygenated, while the latter turns black, and is then insoluble in ammonia. Before I employed this method of analysis, I was desirous to ascertain whether it would be attended with the success I expected: I took ten decigrammes of oxide of cobalt, and ten of the oxide of nickel; and, having dissolved them in nitric acid, precipitated by potash, added to it hyperoxygenated muriate of lime, and attempted their separation by ammonia; which took place completely. A similar trial which I made on a given mixture of green oxide of iron, oxide of cobalt and nickel, showed me more and more that this method would infallibly succeed. But in the second, as in the first trial, the solution of oxide of nickel having been attended, from the beginning to the end of the process, with a disengagement of bubbles, which I ascribed with justice to the decomposition of the ammonia, and which I supposed to be azotic gas, I was desirous to ascertain the cause of it. The ammonia could not be decomposed either by the red oxide of iron, or by the black oxide of cobalt; neither of them was attacked. On the other hand, I was certain that the green oxide of nickel dissolved in ammonia without being deoxidated. This reasoning led me to admit a hyperoxygenated oxide of nickel, and experience soon proved the existence of this oxide, which had been indicated to me by theory. Its distinguishing characters are, that it dissolves without effervescence in sulphuric, nitric, and muriatic acids; in the first two, with a disengagement of oxygen; in the third, with a disengagement of oxygenated muriatic acid, like hyperoxygenated oxide of cobalt. This hyperoxygenated oxide of nickel is black; like it, is formed under several different circumstances; it may be obtained by bringing to a cherry-red heat green oxide of nickel, or by treating this green oxide by oxygenated muriatic acid, or by oxygenated muriatic acid saturated with lime; and the latter method is preferable.

Experiment V.

As these trials left me no doubt in regard to the certainty of separating nickel exactly from cobalt and iron, I agitated the oxides of them recently precipitated with oxygenated muriatic acid, saturated with lime. In a little time they all three passed to the *maximum* of oxygenation. Being then brought into contact with ammonia, the oxide of nickel was the only one dissolved. I decanted the liquor by heat; having then volatilized the ammonia from it, the oxide de-

posited itself under the form of flakes, which gradually assumed consistence. It was of a beautiful green colour, and a solution of it in acids did not change colour by gall-nuts. The precipitate formed in it by ammonia immediately dissolved in an excess of alkali. I was convinced of its purity; but that there might not be room for the least suspicion, I subjected it a second time to the same course of operations already described; and even after having combined it with nitric acid, I caused that salt to crystallize, and took care to employ that only which was in the form of well-defined rhomboidal crystals. I found means to unite thirty-three grammes of that oxide thus prepared, respecting the purity of which chemical analysis could excite no doubt, and formed it into a paste with oil, lamp-black, and twice its weight of very pure borax, matters which could not bring to it any iron. I enclosed this paste in a double Hessian crucible, and subjected it for half an hour to the action of a violent forge heat; the nickel was reduced, but it did not fuse. I observed only in the mass, which was slightly agglutinated, some metallic globules, which were brittle in consequence of the charcoal or borax they contained. I repeated the experiment without better success, though I urged the fire so strongly, that the Hessian crucibles began to fuse. I then resolved to try the fusion a third time, making use of Russinger's crucibles, which are still more refractory than the Hessian. I had at my disposal the forge of the School of Mines, in which are fused without any addition two kilogrammes of soft iron; I took every possible precaution to ensure success; I added borax, and urged the fire in such a manner, that the crucibles were softened, sunk down, and formed only an orbicular mass: and yet I obtained only globules, which were indeed ductile, but very little larger than those of the first experiments. I even could obtain but a very small quantity; several of them were volatilized, and adhered to the cover of the crucible; most of them were disseminated in the glass, and scarcely perceptible by a magnifying-glass; a portion perhaps had flowed with the flux into the ashes. I think I should have succeeded, if, having collected all these globules in an excellent crucible, I had exposed them to a strong heat without any kind of flux. I intend to try this method, which I consider as good, as soon as I can obtain oxide sufficiently pure. It is however certain that this metal is one of the most difficult to be fused; and this property of being in some measure fire-proof, of which no chemist has yet spoken, inclines me more and more to believe that hitherto

it has been obtained always allayed, either with arsenic, or sometimes, no doubt, with cobalt.

Though I had lost a great deal of nickel in these different attempts to fuse it, I however extracted a quantity more than sufficient to establish that property of it respecting which there appeared to be any doubt. I here allude to its magnetism. I can assert, therefore, that the magnetic virtue in it is so striking, that it is almost equal to that of iron; and yet it is certain that it contains none of that metal; for, if it were indebted for it to iron, it is so strong that it ought to contain at least one half of its weight of that metal: in this case chemistry would furnish a variety of means for detecting it: but by all those which it possesses, it cannot discover in nickel the least trace of that metal; and if only 1-50th or even 1-100th part of that metal be added, it immediately becomes sensible by re-agents. It appears, therefore, to be mathematically demonstrated, if I may use the expression, that nickel is really susceptible of attraction; and those who still doubt this truth ought, in admitting these experiments, to be perfectly convinced of it. Several chemists, indeed, have obtained some of it which had no action on the magnetic needle: but it was not pure; they had not separated it from all those matters which alter it; in particular, they had not separated it from the arsenic which may mask its magnetism; as is proved by the experiments I had made on that subject, and with which I shall terminate this memoir. M. Chenevix has himself acknowledged, that the nickel not susceptible of attraction, which he obtained, had in it a mixture of arsenic. This error could not long escape so distinguished a chemist.

Having fused together equal parts of nickel and arsenic, I obtained a brittle allay, granulated, easy to be fused, and which was not susceptible of attraction: half a part of arsenic is sufficient to mask the property of iron; a quarter only weakens it. I made the first of these allays by heating in a crucible equal parts of iron and arsenic, and the second with one part of iron and half a part of arsenic. I was desirous to ascertain whether other metals, and particularly copper, would also have the property of rendering iron unsusceptible of attraction. I made four of these allays: in the first I put a fourth of iron, in the second an eighth, in the third a twelfth, and in the fourth a sixteenth: all of them were magnetic, and were the more so, as they contained more iron, and the more ductile, as they contained less. By dissolving them in acids the presence of iron was easily detected by gall-nuts. Such is the series of experiments of which this memoir is composed: if not numerous, they are

more than sufficient to solve the question I proposed; they indeed establish, in an incontestable manner, that pure nickel really possesses the magnetic virtue which Bergman and several chemists with him did not hesitate to ascribe to it: they prove that this property, which it participates with iron, and no doubt with cobalt, may be masked or destroyed in these metals by their union with different bodies, and particularly by arsenic. Hence we necessarily deduce this consequence, that a magnetic bar is an incorrect instrument for detecting them, and cannot with certainty indicate the presence of them; but where they are in a state of mixture only, and not in that of combination, they confirm the property of semi-ductility, which has been some time observed in it, and its relation in this point of view to zinc and mercury. They show that it is much more difficult to fuse it than has been hitherto supposed, and give reason to presume that it has never yet been obtained but allayed either with arsenic or cobalt. They show that it is susceptible of hyper-oxygenation, and of forming a new black oxide, soluble in sulphuric and nitric acid, with a disengagement of oxygen, and in muriatic acid with a disengagement of oxygenated muriatic acid. They confirm the presence of bismuth in ore of nickel, and the transition of the latter to the state of insoluble arseniate when treated by nitric acid. They give a sure method for extracting arsenic from any ore whatever, and of determining the quantity. In the last place, they furnish a process free from every suspicion, which was wanting to analysis, and which was long desired, for separating nickel from cobalt and iron, and consequently for obtaining the first two metals in their greatest state of purity.

VIII. *On the Orbit of the new Planet discovered by Mr.* HARDING *at the Observatory of Lilienthal, near Bremen, on the* 1*st of September* 1804.

HAVING been favoured by an eminent astronomer with a chart (see Plate III.) representing the apparent path of the new planet, accompanied with the following observations in regard to the use of it, we flatter ourselves it will prove gratifying to our astronomical readers.

" The apparent path of the new planet was laid down in this chart from observations made from September 29 to October 12, 1804. The remaining part of the orbit, which is carried on to the middle of November, was laid down on a supposition that the planet's mean distance is about the same as that of Pallas, as the retrograde motion seems nearly to

to correspond with that of the same planet when near its opposition. It cannot therefore be expected that the orbit laid down in the chart will be very correct: but, as great care has been taken to lay down all the stars as far as those of the ninth magnitude with as much accuracy as possible, it is hoped this small map will be found particularly useful to those who may not be provided with instruments for taking right ascensions and declinations, but who, being provided with a good telescope, may wish to find it; which by help of this chart and a good general atlas or pair of globes they may easily do, by first finding some of the principal stars and then those of a smaller magnitude, by which they will be enabled to find those laid down in this map; and, by comparing their positions with their apparent places in the heavens, will be soon led to discover the planet by its motion among them. The planet is a little brighter than those marked in the map of the eighth magnitude; and, if the places of these stars be carefully observed, can hardly be mistaken."

IX. *Description of improved Malt Kilns for drying Malt by heated Air*.*

Fig. 1. (Plate II.) front view of the malt kiln *aa*, the furnace door. *b*, the fire, through which the air rises, the grate being of the common kind. *c* a cast iron tube, which passing through the fire, and having one end open to the external air, and the other open into the kiln, conveys heated air to the grain. *d*, a flue around the fire, in which air is also heated and conveyed to the grain. *e*, the ash pit. *f*, the chimney.

Fig. 2. a side view of a malt kiln, in which the grain is dried by heated air, as in fig. 1, but in which the air necessary for combustion of the fuel descends through the grate. *a*, the fire. *b*, the grate. *c*, the door of the furnace. *d*, the door of the ash pit. *e*, the air tube. *f*, the ash pit. *g*, the end of the air tube entering the space below *h*, the kiln head, which is composed of tiles perforated with small holes, lying on the joists *i*, and supporting the malt *k*. *l l*, the windows, through which a current of air may freely enter or escape. *m*, the air outlets above. If a distiller finds his buildings so relatively situated that he can lead the air cylinder of his malt kiln through the flue of his still or mash boiler furnace, the expense of fuel for drying malt may be saved.

* From Parliamentary Report on the Distilleries in Scotland.

X. *Cursory Sketch of a Specimen of a Dictionary of the Gealic Language.* *By* Cuthbert Gordon, *M. D.*

English.	Gealic.	Gealic Roots.	Literal English Translation.
God Supreme.	Ahan..........	AH—AN—or EN.....	AH—He, and only He; EN—He and He alone, is only He; *i. e.* One or Unity: the First Person in the Hypostasis.
Angel.	Agelloh.........	Ag—Ell—Oh..........	Ag—Attendant; Ell—Flaming Fire; Oh—Out of; *i. e.* made out of Flaming Fire, to execute and minister the will of Him who made him.
Heaven.	Flainoss.	Fla—Ind—Oss.	Fla—The Resplendence of Flame or Light, not a consuming or devouring Flame, but a multiplied combining Brightness; its consuming and devouring Force transmuted into itself, to add Light unutterable; Ind—Mind; Oss—Elevated or lifted up; *i. e.* Mind illuminated by inexpressible Light, elevated with ineffable joy.
Earth.........	Talow...........	Tal—Ow.	Tal—Blind, Opaque, without either Life or Spirit; O—An Egg or Matrice; *i. e.* a Matrix barren and unprofitable, but as occasionally impregnated by the Spirit.

English.

English.	Gealic.	Gealic Roots.	Literal English Translation.
Air.	Awhir.	Aw—Hir.	Aw—Raw Vapours or Exhalations; Hir, the oblique case of Tir—Land or Ground; *i. e.* raw and indigested vapours rising out of the ground; digested.
The Soul.	Ahnin or E'nin.	Ahn or E'n—In.	E'n—One; In—Mind; *i. e.* the Mind drawing near or approaching to Unity, as participating thereof.
Adam.	Ahguth or A'gu.	Ah—Guth or A'gu.	Ah—The First Person in the Hypostasis; Guth or Gu, the oblique case of Cuth or Cu—Breath or Word; *i. e.* Soul breathed into Man by the Almighty.
Eve.	Ow.	Ow.	Ow—Mother. Ow is likewise the commanding Number in the Gealic Precept, by placing Unity before it, thus, 10, and makes Deic, Depart, the imperative of Dec.
A Father.	Aherr.	Ah—Err.	Ah—The Almighty; Err, the oblique case of Pherr—Man; *i. e.* a man who in all respects, mindful of his duty to the Almighty, begets his like.
Spirit.	Sbierid.	'S—Bi—Er—I'd.	'S—Is; Bi—The Phlogiston; Er—or; I'd—Elaborated into inconceivable Purity; *i. e.* Matter animated.
A Virgin.	Owi.	Ow—I.	Ow—An Egg whole and unbroken; I—Spirit; *i. e.* an egg whole and unbroken, its spirit and taste remaining in it.

English.

English.	Gealic.	Gealic Roots.	Literal English Translation.
A Woman.	Ow.	Ow	Ow—Matrix, from Owi, a Virgin. Woman in general is translated M'nowi, my virgin, being supposed to have been somebody's virgin. The common pronunciation M'nawi is a corruption of M'nowi; we say Murowi, the Virgin Mary, and not Murawi. Ow is the symbol of Woman, and also of our Globe, the Earth.
Fortune.	Ordawn.	Or—Dawn.	Or—Give or Bestow; Dawn—Decree or Fate; *i. e.* predestined, decreed by Fate or invincible Necessity.
The Heart.	Cari.	Car—I.	Car—A Throne or Seat; I—Soul or Spirit; *i. e.* the Seat of the Soul or Spirit.
Christ.	C'riist.	C'ri—Ist.	C'ri—Heart; Ist—Knower or Searcher; *i. e.* the Searcher of the Heart.
Love.	C'riawh.	C'ri—Awgh.	C'ri—The Heart; Awgh—Goodness; *i. e.* the goodness of the Heart—Charity.
Life.	Bioh.	Bi—Oh.	Bi—Phlogiston; Oh—Out of; *i. e.* the Phlogiston laboured into Life or Spirit.
Hell.	Ell.	Ell.	Ell—Flaming Fire.
A Wood.	Coill.	Co—Ill.	Co—A Concert; Ill—Warbling; *i. e.* a concert of warblers or singing birds.

English.

English.	Gealic.	Gealic Roots.	Literal English Translation.
Parliament.	Praliaind.	Pra—Li—A—Ind.	Pra—Judgment; Li—Gray; A—In; Ind—Mind; *i. e.* the judgment of gray or experienced minds assembled.
Zion.	Sihom.	Si—Hom.	Si—Peace; Hom, the oblique case of Tom—A mount or rising ground; *i. e.* Mount Peace, Peace Hill.
Prayer.	Urini.	Ur—In—I.	Ur—Heat or Warmth; In—Mind; I—God; *i. e.* the fervour of the mind crying unto God.
Desire.	Ierr.	I—Err.	I—Spirit or Soul; Err, the oblique case of Pherr—Man; *i. e.* wish or seek; eagerness to obtain or enjoy.
Melchizedec.	Mulchize'dec.	'Mul—Chiz—E'—Dec.	'Mul—My all; Chiz—Crucified; E''—He; Dec—Depart or Death; *i. e.* the Saviour or Redeemer conquered Death.
Jerusalem.	Jerrusilom.	Jerr—U—Si—Lom.	I'err—Seek or Desire; U—Thou; Si—Peace; Lom—To me; *i. e.* seek my peace, wish prosperity to me.
Messiah.	Missiah.	Mis—Si—Ah.	Mis—I am; Si—The Peace; Ah—The Almighty; *i. e.* I am the Peace of the Almighty God.
Shecinah.	Shec'inah.	She—C'in—Ah.	She—That is; C'in—To my mind; Ah—The Almighty—He; *i. e.* the Divine Presence.

XI. *New*

XI. *New Method of rendering Platina malleable. By Count* Apollos Moussin Poushkin. *Made public, at his Request, by* Charles Hatchett, *Esq. F. R. S.**

1. Precipitate the platina from its solution by muriate of ammonia, and wash the precipitate with a little cold water.

2. Reduce it in a convenient crucible to the well-known spungy metallic texture; which wash two or three times with boiling water, to carry off any portion of saline matter which may have escaped the action of the fire.

3. Boil it for about half an hour in as much water mixed with one tenth part of muriatic acid as will cover the mass to the depth of about half an inch in a convenient glass vessel. This will carry off any quantity of iron that might still exist in the metal.

4. Decant the acid water, and edulcorate or strongly ignite the platina.

5. To one part of this metal take two parts of mercury, and amalgamate in a glass or porphyry mortar. This amalgamation takes place very readily. The proper method of conducting it is to take about two drams of mercury to three drams of platina, and amalgamate them together; and to this amalgam may be added alternate small quantities of platina and mercury till the whole of the two metals are combined. Several pounds may be thus amalgamated in a few hours, and in the large way a proper mill might shorten the operation.

6. After the amalgam is completely produced, it must be quickly moulded in bars or plates, or any other forms that may be preferred; taking care that these moulded pieces should at least be half an inch in thickness, and of a proper length to manage them afterwards in the fire; it is also requisite that the moulds should be perfectly even and smooth. Half an hour after the pieces are formed they begin to harden by the oxidation of the mercury, and change their brilliant metallic colour for a dull leaden one.

7. As soon as the pieces have acquired a proper degree of hardness to be handled without danger of breaking, which commonly takes place in a little more than an hour, place them in a proper furnace, and keep them ignited under a muffle or in a small reverberatory. No other precau-

* From Nicholson's Journal, vol. ix. Oct. 1804.

tion is necessary in this operation but that of not breaking the pieces during their transport. The mercury flies off during the heat, and the platina remains perfectly solid; so that, after being strongly ignited two or three times before the bellows, it may be forged or laminated in the same manner as gold or silver; care being taken, at the commencement of the forging, or of passing it between rollers, not to apply too great a force till the metal has acquired all its density. It is almost superfluous to add, that in evaporating the mercury from large quantities of amalgam, a proper apparatus, such as in the silver amalgamation, must be employed to receive the volatilized mercury; but for small quantities, where the loss of this metal is of no consequence, the furnace must have a proper chimney to carry off the metallic vapours. When the platina comes out of the first fire its dimensions are about two thirteenth parts smaller every way than the original amalgam from the mould. The whole of this operation seems to be governed by the pressure of the atmosphere and the laws of cohesive attraction; for the air is driven out from between the molecules of the platina, which by their solution in mercury are most probably in their primitive and consequently uniform figure. It is very visible, and at the same time a very amusing phænomenon to observe, (during the process of ignition, which is performed in four or five minutes) how the platina contracts every way into itself, as if pressed by some external force*.

I have also lately obtained triple salts of muriate of platina with muriate of ponderous earth; and also with muriate of magnesia; and I strongly suspect that every other earth except the siliceous, and even the metals, are susceptible of such triple combinations. I have likewise obtained a very beautiful salt of platina by the combination of soda and platina with the muriatic acid; a combination which Bergman and several other chemists deny. The best manner of obtain-

* In the Count's letter to Mr. Hatchett, requesting him to publish the method in the text (communicated to Mr. H. some years ago), the following addition is given: (in French.)

"As soon as my amalgam of mercury is made, I compress the same in tubes of wood, by the pressure of an iron screw upon a cylinder of wood, adapted to the bore of the tube. This forces out the superabundant mercury from the amalgam, and renders it solid. After two or three hours I burn upon the coals, or in a crucible lined with charcoal, the sheath in which the amalgam is contained, and urge the fire to a white heat; after which I take out the platina in a very solid state, fit to be forged."

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ing it is by dissolving the platina in nitrous acid, to which, for that purpose, two parts of muriate of soda and one of platina are added. The platina must be made in a retort with its receiver; and after about four fifths of the fluid have come over, the process must be interrupted, and the whole left to cool in the sand bath. The salt crystallizes in fine prisms, which are sometimes four or five inches long, and either red brown, like titanium, yellow, like amber, or of a beautiful coquelicot colour, according to the purity of the platina. I enclose here my address during my absence, and hope you will receive with indulgence the contents of this letter.

I am with great regard, sir,
Your most humble and obedient servant,
Count APOLLOS MOUSSIN POUSHKIN.

XII. *Notices respecting New Books.*

THE physicians of the original Vaccine Pock Institution, established in 1799, have lately published "*A Statement of Evidence from Trials by Inoculation of Variolous and Vaccine Matter; to judge of the Question, Whether or not a Person can undergo the Small-Pox after being affected by the Cow-Pock,*" which is well deserving the attention of medical men. The chief object of the authors seems to have been to answer, by decisive experiments, the objections of Mr. Goldson, in a recent publication, questioning the efficacy of vaccine inoculation; and they have taken the best means to ascertain the question, namely, re-inoculating, with variolous matter, a number of patients who had some years ago been inoculated for the cow-pock. The experiments related show, that above fifty persons who had been vaccinated from three to five years ago, and ten who had been vaccinated at a later period, were incapable of taking the small-pox by inoculation in circumstances chosen as most favourable for infection. For many of the subjects were exposed to the effluvia from small-pox patients; they were all inoculated in three times the usual number of places; they were all inoculated with efficacious and recent matter; and with many of them unusual pains were bestowed to introduce the matter quite fluid immediately from the variolous patient. In these it seems fair to calculate that not more than one, or at most two, of these sixty persons would have escaped the small-pox, if they had not already gone

gone through that disease, or its vicarious affection, the cow-pock. They likewise strikingly manifest, that the same person is equally incapable of taking the cow-pock a second time, as of the small-pox, as hath been proved five years ago, and been subsequently confirmed; and it has been elsewhere shown by many trials, that a person cannot take the cow-pock subsequently to the small-pox.

We regret that our limits prevent our giving a large extract from the work.

XIII. *Proceedings of Learned Societies.*

BOARD OF AGRICULTURE.

Premiums offered by this Board.

[Continued from our last vol. p. 386.]

L*AYING down to Grass.*—To the person who shall, in the most satisfactory manner, make the following experiment in laying down land to grass, on a scale of not less than three acres to each division, and report the result to the board—*the gold medal.*

The land to be divided into three parts—one sown with grass-seeds, among barley or oats, in the spring, on land that was fallowed, or yielded turnips the preceding year; one sown with grass-seeds alone, in July or August, or, at the option of the candidate, with buck-wheat, having been fallowed from the Michaelmas preceding; and the third sown with grass-seeds and wheat, early in September, having been fallowed, or cropped with tares or turnips; the soil to be of the same quality; the grass-seeds the same in each division. The grass to be fed with sheep the first year. Accounts, stating the comparative expenses and success of the three methods, verified by certificates, to be produced to the board, on or before the first Tuesday in December, 1805.—The same premium for 1806.

Seed Wheat.—To the person who shall, by the most satisfactory comparative experiments, ascertain the proper quantity of seed-wheat to be used per acre, in the common or broad-cast husbandry; not less than one acre to be applied to each quantity of seed—*the gold medal.*

Accounts, containing a particular description of the soil, and the preparation thereof, including the manuring, if any; also the time of sowing; the various quantities of seed employed; with the respective products, verified by certificates, to be produced to the board, on or before the

first Tuesday in December, 1804.—The same premium for 1805.

Seed Barley.—To the person who shall, by the most satisfactory comparative experiments, ascertain the proper quantity of seed-barley to be used per acre, in the common or broad-cast husbandry; not less than one acre to be applied to each quantity of seed—*the gold medal.*

Accounts, containing a particular description of the soil, and the preparation thereof, including the manuring, if any; also the time of sowing; the various quantities of seed employed; with the respective products, verified by certificates, to be produced to the board, on or before the first Tuesday in December, 1804.—The same premium for 1805.

Seed Oats.—The same premium, and on the same conditions, to be given, for ascertaining the proper quantity of seed-oats.

Preparations for Wheat.—To the person who shall make and report to the board, the most satisfactory experiments, comparing various preparations for wheat, on the same soil —*the gold medal.*

The preparations to include beans or pease, drilled and horse- and hand-hoed; red clover; buck-wheat; tankard turnips, eaten on the land; winter tares, mown for soiling; and buck-wheat, ploughed in for a manure.—Accounts, containing a description of the soil, previous culture and manure, if any, and the produce and value of the preparatory crops; with the produce of the wheat; verified by certificates, to be produced on or before the first Tuesday in March, 1807.

Culture of Wheat.—To the person who shall send to the board, the best essay on the culture of wheat, which shall include the useful facts hitherto published, with such additions as the writer may be able to make, either from his own experiments, or those of others within his knowledge —*fifty guineas.*—For the next best essay—*thirty guineas.* —For the next best—*twenty guineas.*—Accounts to be produced on or before the first Tuesday in February, 1806.

FRENCH NATIONAL INSTITUTE.

M. de Humboldt, correspondent of the institute, read, in the last sitting of the physical and mathematical class, a third memoir on his travels with M. Bonpland in the interior of South-America and Mexico. In the first he traced out the observations made in the Atlantic Ocean at the

the summit of the Peak of Teneriffe and in the province of New Andalusia. In the second he gave an account of the operations performed in the province of Venezuela, and in the plains of Calobozo, where he made curious experiments on the *gymnotus electricus*. In the third memoir he gave a short view of his dangerous navigation on the Oronoquo, the Rio Negro, and the Carsequiare, undertaken for the purpose of determining astronomically the communication of the Orinaro with the river Amazon. These memoirs, which embrace every thing interesting in regard to the geography, botany, and mineralogy of these countries, and of the moral history of man, will soon be printed, to give to the public a short view of this expedition, until the observations themselves are published. Several drawings made by M. Humboldt are now engraving.

SOCIETY OF ARTS AND SCIENCES AT MENTZ.

This society, in its first public sitting in the month of March last, proposed, as the subject of a prize for 1805, an eulogy on John Gaensfleisch de Sorgenloch, named Guttemberg, a native of Mentz, one of the inventors of printing. The prize will be a gold medal of the weight of 240 francs, with the image of Guttemberg. The eulogy may be written in French or in German. The competitors must transmit their productions, post-paid, to the president before the middle of May 1805.

The same society has resolved to raise a monument to the memory of Guttemberg. It is to consist of a public fountain, and a premium will be given for the execution of it. For this purpose a subscription has been opened, and all the members of the republic of letters are invited to contribute towards it.

XIV. *Intelligence and Miscellaneous Articles.*

AERIAL NAVIGATION.

By Professor Robertson.

Riga, August 24.

THE following are some further particulars respecting the aërial excursion of M. Robertson, which took place at six o'clock in the evening of the 18th. At the end of fifteen minutes he lost himself, at the height of 500 fathoms, in thick clouds strongly agitated by the wind. When he set out

out the barometer stood at 28 in. 3 lin.; and, at the height to which he had attained, it fell to 23 in. Between the mass of clouds which rolled over him in an awful manner, like mountains, the thermometer fell suddenly to 5 degrees above zero. The balloon was whirled round and carried forward with a most violent motion. No scientific experiments could here be made, except a few observations in regard to the management of a balloon; such as the simplest method of fixing the balloon at a determinate height, and of securing it; also to calculate the velocity of its fall in a diagonal line on descending, and thereby to ascertain the moment of its arrival at the earth, which is always the most dangerous part in an aërial excursion. M. Robertson will publish an account of these and of other experiments. While hovering in the clouds, the aërial traveller discovered below him a fir wood of great extent; he proceeded over it a mile in order to take advantage of the first interval between the trees, and suffered himself to descend in an open place, which was scarcely so large as twice the diameter of the machine. That he might be able to dispense with the dubious and dangerous assistance of men in fastening the car, M. Robertson employed a kind of hooked anchors. In the middle of a thick wood, 20 versts distant from Riga, he alighted alone; and the balloon was nearly emptied and folded up, when he saw a shepherd and his two boys, whom he called to give him their assistance, and who showed him the way. The excursion continued three quarters of an hour. Messrs. Von Berg, Blankenhagen, Meyer and Schwarz, had followed the aëronaut speedily, to draw up the account. M. Robertson is justly entitled to the praise of having applied all his aërial excursions to the purpose of scientific experiments, and of throwing light, if possible, on experiments which all his predecessors have rather involved in darkness.

By the same.

Vienna, October 10.

On the 8th, Professor Robertson undertook an aërial excursion here, with the best success, in the presence of their imperial highnesses the archdukes and a numerous crowd of spectators. He ascended from the Prater about a quarter past five in the afternoon. He rose to a considerable height, and sent down a parachute, which carried unhurt to the earth a living animal. This aërial excursion is remarkable, on account of an experiment made by Professor Robertson

bertson

bertson with a large sail, which served to guide his way; but as this sail would have shaken his balloon too much, he fastened it to a smaller one, the motion of which was independent of that of the other. By these means he was enabled to direct his balloon in an oblique line, fifteen degrees different from that in which he would have been conducted by the wind. Professor Robertson observed, that the atmospheric electricity suddenly disappeared as often as he moved over a forest, though the sky was serene, and though at other times it always gave strong and abundant signs of its existence. About three quarters past five he had attained to his greatest height, namely 700 fathoms; the thermometer then stood at six degrees above zero. About six o'clock the Professor descended in a plain, near the forest of Tresdorf, to the north of Kronenburg, at the distance of four leagues and a half from Vienna. The balloon hovered a long time over the plain, because the anchor which was thrown out did not find a sufficient hold in the new-tilled land; and as the Professor observed that he was about to be driven against two large trees which stood in his way, he threw the extremity of his sail against the earth, and, in consequence of the shock it produced, rose over the trees, which then caught the anchor and stopped the balloon. M. Robertson here obtained every assistance from the surveyor M. Oettl and M. Bartsch, who were here hunting. Yesterday morning he returned hither about eight o'clock in a carriage attended by the populace, and entered the city amidst loud acclamations.

By M. Gay-Lussac.

M. Gay-Lussac has given the following account of his last* aërostatic ascent, to the first class of the National Institute.

He ascended on the 6th of September at ten in the morning, from the Jardin du Conservatoire des Arts et Metiers, which is about 20 toises higher than the level of the sea. His barometer then stood at 28 in. 3·33 lines, and the mercurial centigrade thermometer indicated in the shade 27·75 degrees. These two instruments varied very little at the earth, or during the course of the ascension, and their changes were observed every hour by M. Bouvard at the Observatory. M. Gay-Lussac in ascending made a great many observations on the barometer, the thermometer, the hygrometer and the magnetic needle.

* For an account of his former ascent see our last Number.

At the height of 3902 metres, or 2002 toises, he found the inclination of the needle the same as at the surface of the earth. The duration of the oscillations of a horizontal needle, made with great care by that able artist Fortin, magnetised by Coulomb and suspended by a silk thread, were also the same. M. Gay-Lussac never found any sensible difference in their duration. When he reached the height of 6675 metres, or 3425 toises, he opened two glass balloons which had been exhausted at the earth, and which had preserved a complete vacuum. The air entered into them with a hissing noise; and when they were filled he closed them. He continued to rise to the height of 7017 metres, or 3600 toises; his barometer was then 12 in. 1·76 lin. and his thermometer in the shade marked 9½ degrees below the temperature of melting ice.—This height, the greatest to which any person ever ascended, surpasses by 600 metres the summit of Chimboraço in Peru, the highest mountain known on the earth. M. Gay-Lussac still however saw clouds above him, but which appeared to be at a great elevation. His pulse was accelerated; and the number of pulsations, which at the earth was only 62, increased to 95. His respiration was a little confined; but he thinks he could have risen to the height of 8000 metres, without experiencing much inconvenience, had he not been so imprudent as to throw out before, the ballast which would have been necessary to moderate his ascent. He therefore descended slowly, and with those precautions which his first ascent had shown to be necessary. At 45 minutes past three he reached the earth, without the slightest accident, six leagues to the north of Rouen, at the small village of Saint-Gourgon; the inhabitants of which assembled on seeing his balloon, gave him every assistance, and treated him with the utmost hospitality.

On his return to Paris, his first care was to analyse the air he had collected in his ascent. One of his balloons being opened under water became half filled with it; which proves that no foreign air had entered it. On comparing the air of this balloon with that collected at the surface of the earth, he ascertained by several very exact eudiometric processes, that the proportions of oxygen and azot in the two airs were perfectly equal.

This interesting aërial voyage has therefore confirmed two important points in natural philosophy; namely, 1st, That the magnetic force experiences no sensible variation, either in its inclination or its intensity, from the surface

of

of the earth to the greatest heights to which it is possible to ascend: 2d. That in this interval the constitution of the atmosphere is entirely the same. M. Gay-Lussac observed, that the heat decreased nearly in arithmetical progression in proportion as he rose into the atmosphere, and that each degree of the depression of his centigrade thermometer corresponded to an elevation of about 85 toises 5 feet.

By Count Zambeccari.

Venice, October 2.

Count Zambeccari has published a long account of his last aërial voyage, the principal particulars of which are contained in the following extract:

Near Rouanzo the two aëronauts, he and Dr. Andreoli, descended to about within five hundred feet of the earth, after which they re-ascended. The machine traversed a cloud, but without experiencing the effects of electricity. About one o'clock they found themselves above Capo d'Argine, six Italian miles from Bologna. The Count here wished to descend; and having got within a short distance of the earth, he made his anchor fast to a tree. The balloon having by this movement acquired an oblique direction, the lamp was overturned, and the spirit of wine it contained fell to the bottom of the car and took fire. The flames soon reached a vessel containing thirty pounds of spirit of wine. The vessel burst, and the flames spread more and more. At length they extended to the clothes of the aëronauts, and even threatened the netting and the ropes by which the car was suspended. Zambeccari laid hold of a bottle of water and extinguished the fire in his clothes. Andreoli, who only thought of escaping, glided down by the anchor-rope to the tree, and fell thence to the ground without sustaining much hurt. The balloon being freed from the weight of about a quintal and a half, rose rapidly with Count Zambeccari, and in a moment disappeared above the clouds. The Count, however, did not lose his presence of mind, but continued to extinguish the fire both in his clothes and in the car.

The balloon was then carried by a strong current of air towards the Adriatic, and at three o'clock the Count perceived the coast of Comachio, but from such an elevation that he could hardly distinguish it. Soon after he fell into the sea at about the distance of 25 Italian miles from the coast. The car, which was half burnt, sunk, and Count Zambeccari, who held fast by the ropes of the balloon, had the water often up to his neck. Apprehensive that lassitude would

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oblige him to let go his hold, or that he should be overcome by sleep, he endeavoured to fasten himself to a rope. By means of a bit of glass he detached one from the balloon, and fastened it round his body, the other end of it being fixed to the machine. In this situation he floated on the water for some hours, the balloon being still inflated.

At length, about six in the evening, he observed seven fishing-boats, the people in four of which, being struck with terror, betook themselves to flight, imagining that they saw some strange kind of sea monster. The other three approached, and took from the water the unfortunate aëronaut half burnt, after having spent four hours at sea, amidst the most dreadful anguish. The fishermen attempted also to seize the balloon; but as soon as they had cut the ropes it rose and took its course towards the Turkish coast. During some days great apprehensions were entertained for the right hand of the aëronaut, which had been severely burnt; but happily amputation has not been found necessary.

VACCINATION.

We have devoted a larger portion of our present Number to the Cow-Pock than we usually allow to one subject, and its importance at the present moment demands it.

Two cases of an eruptive disorder, supposed to be the small-pox, subsequent to vaccination at the Inoculation Hospital, and of course under the management of professional men of the greatest experience, have lately occurred in one family, that of Mr. Hodges, Fulwood's-Rents, Holborn. These cases have excited more alarm, attention, and examination, than any that have taken place since the commencement of the new practice. A considerable part of the medical practitioners of London have visited this family, and the accounts given have been one of the most popular themes of medical conversation during the last month. Different opinions are entertained on the subject by medical men, the greater part of whom may be considered as having divided themselves into two parties: one representing these disorders to have been nothing more than the chicken-pock, and their account has even been published in the last number of the Medical and Physical Journal, in which the other party is charged ith shunning the inquiry by breaking their engagements to continue their visits to the patients, in consequence of the contrary opinion which they had given. The other, however, have uniformly declared the cases to be

those of the small-pox; and maintain that the result of the cases has removed all doubt; for persons have been inoculated with the matter from these patients, by which the most distinct small-pox have been produced, and exhibited at the Vaccine Institution in Broad-street. By this institution the investigation has been carried to a great extent. The gentlemen of that establishment have found, on what they consider clear evidence, that the two patients had, within from two to four years, undergone the cow-pock in such a manner as has been usually considered by the best judges sufficient to afford security against the small-pox. It is not therefore surprising that the opponents of vaccination, as well as many well-disposed but not well-informed persons, should speak unfavourably of the new practice, and endeavour to set it aside. On the other hand, the friends of vaccination represent these cases as on the same footing with those of persons taking the small-pox the second time, and maintain that the instances of taking the small-pox after cow-pock, are not greater at present than those of taking the small-pox the second time. We understand that a somewhat different conclusion from any of the above, is likely to be drawn by the medical establishment of the Broad-street Institution; namely, that it does now appear that the best authenticated instances of small-pox after the cow-pock, occur much more frequently than even the supposed instances of small-pox a second time; yet they are of opinion that, provided the constitution be duly affected by the vaccine infection, it is as certain a preventive of the small-pox as variolous inoculation, and hence that it will be necessary in future to take precautions which have hitherto not been known or commonly employed. This will give some additional trouble, and render it necessary for practitioners to pay more attention to the study of the cow-pock than they have hitherto done; and it will show the danger of the practice in the hands of persons not of the medical profession. We understand, also, that notice has been given by one of the medical gentlemen of the above institution, that he will present a memoir at the next quarterly meeting, to communicate the measures to be taken to obtain security for the future, and to satisfy the minds of families who may be in doubt respecting their children already inoculated. From this account it would seem as if the statement of evidence lately published by the Vaccine Institution, before the occurrence of the above cases, was given more strongly in favour of the practice than that body would now be inclined to give it; though we confess

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we can see no grounds for hesitation on that point; for, as they were merely stating facts, they had every right to draw from them any conclusions whatever that were warranted by the premises. It may be proper, however, to observe here, that that body seems to have anticipated the possibility of such an occurrence as has taken place; for in their Report, published in 1803, p. 65, we find the following passage, which indeed they have quoted on the title-page of their last Report:—"That many persons inoculated for the cow-pock in the years 1799, 1800, and even 1801 and 1802, have already, and may hereafter, take the small-pox, is a reasonable expectation, from the characteristic properties of the vaccina not being known to the inoculators by their own experience, nor from the description of authors."

We cannot dismiss this subject without observing, that even if it were proved that the two cases in Fulwood's-Rents were cases of real small-pox after real vaccination, they furnish no sound argument against the vaccine inoculation; for all that can fairly be drawn from them is, that one at most in twenty thousand may take the small-pox after the cow-pock: and this surely is sufficiently in its favour, with all its other advantages, to deter parents and medical men from the propagation of a disease a thousand fold more afflicting to the human race than the pestilence—a disease that has swept from the face of the earth a greater number of victims than all the wars that have occurred since the death of Abel—a disease that may and will be banished from the world by the best gift of heaven, the Cow-pock!

We freely confess that we are astonished medical men should have given so much weight to these, or to fifty such cases, if as many could be adduced; and we maintain, that before they can be considered as being fairly proved, some experiments that do not seem to have occurred to them are called for. Dr. Thornton has shown * that the small-pox which sometimes present themselves on nurses that have before had the disease, will, by inoculation, give the small-pox. Has the effect of rubbing variolous matter into open pustules of chicken-pox or swine-pox, been tried on patients that have before gone through the small-pox or the cow-pock? Since it is possible, that nurses may have small-pox after going through that disease, and that matter from such pustules can give the real small-pox, as stated by Dr. Thornton,—would it be strange that some small-pox pustules, capable of giving

* See p. 57 and 58 of our present Number.

that

that disease, might rise on a child among swine-pox, if that child was much exposed to infection, even though that child had the cow-pock or the small-pox before?

DEATH OF MECHAIN.

The death of M. Mechain is one of the greatest losses that astronomy could sustain; it adds a very remarkable instance to the martyrology of that science, since he died a sacrifice to his zeal for one of the most important and difficult operations.

Peter Francis Andrew Mechain was born at Laon on the 16th of August 1744. His letters made known to me his turn for astronomy, and I had the happiness of being able to fix him at Paris in 1772. On the 13th of August 1774, the academy approved of his first memoir on an eclipse he had observed at Versailles on the 11th of April. He was then attached to the depôt of the marine, where he made immense calculations for the improvement of geographical charts. He discovered and calculated several comets. He gained the prize of the academy in 1782, respecting the comet of 1661, the return of which was expected in 1790, and the same year was admitted a member. He was charged with the *Connoissance des Tems*, and after 1788 that work was much improved; it was enriched every year with the labours of M. Mechain. In 1792 he was charged with the grand labour of the meridian from Dunkirk to Barcelona, in conjunction with M. Delambre. He returned in 1798. But to complete this work he was desirous of continuing it as far as the Balearean Isles, and he set out for that purpose in 1803. He had already examined with incredible labour all the stations, and had terminated three, when he was attacked by that fever which prevails every year on the coast of Valentia, occasioned by the marshes and rivers, and died on the 20th of September 1804. A fuller account of his labours, with a portrait of him, engraved in 1800, will be found in Von Zach's Journal, and I propose to enlarge it in my history of astronomy for 1804.

It is the melancholy fruit of my old age, that I have always to write the eulogy of my pupils to console myself for their loss. DE LALANDE.

EARTHQUAKE.

Saint Servan, Sept. 24th.

Yesterday at five or six minutes after four in the afternoon, a shock of an earthquake, accompanied with a hollow noise like the discharge of a great number of pieces of artillery, or

or the explosion of a powder magazine blown up at some distance, was felt here; its direction seemed to be from east to west; the duration of it was about forty-three seconds. The wind was then north-west, and it had blown a pretty fresh gale the preceding night, as well as during a part of the day. It was at that time low water. The oscillations of the earth were so strong that they were observed not only in the houses, where the floors, partitions, windows, and furniture were strongly agitated, but also in the open air and on the sea shore. The people were then assembled at vespers, and many of them were so frightened, that they ran out of the churches.

An hour and twenty minutes after, that is to say, about twenty-six minutes after five, another shock was felt; it was accompanied also with a strong detonation, but the agitation was less than during the former. This earthquake was experienced at the same time at Dinan, and in the interior of the country, but it is not supposed to have done any damage. The wind continues to blow with violence from north-north-east, the atmosphere is filled with clouds, and it rains abundantly.

I was in the country at the time of the earthquake, and it was on the rocks bordering the beautiful bay of Concalle that I felt it. From the place where I was walking I could see at once Granville, Avranches, Dol, and Mount Saint Michel. The noise, at the moment of the first shock, resounded along that immense shore as if all the guns at St. Malo had been fired at the same time.

Several officers of the navy, who have been in the East and West Indies, assured me that they have experienced shocks much more violent, but that they never heard stronger detonations.

Letters from Italy state that earthquakes occur almost daily at Spoletto, which is nearly deserted by its inhabitants. The lava of Vesuvius constantly overflows and alarms the neighbouring country. Most of the towns and villages in its vicinity are abandoned, the people having carried with them their most valuable effects, concluding, from several circumstances, that some new and terrible explosion is not distant.

Letters from Sicily state, that on the 10th of August Mount Ætna ceased, for twenty-four hours, even to emit smoke; but this calm was succeeded on the 12th, early in the morning, with a terrible explosion, and a noise as if millions of cannons had been fired at once. When the last letters of the 18th left that island, a shower of fire conti-

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nued still for three leagues round Ætna, from the burning materials thrown up by this mountain. No earthquakes had been experienced; but a subterraneous sound, like thunder, was heard all over Sicily, particularly at and near Messina.

NATURAL HISTORY.

The accounts given of the subtility of the venom of the viper have lately been confirmed in the forest of Fontainbleau. The dog of a hunter, which was bitten in the nose, died in less than ten minutes. A woman who had returned with a bundle of sticks which she had picked up in the forest, having thrown it on the ground, a viper concealed in it crept out and bit the woman's child, which died in the course of the day. A robust peasant was also bitten; and though those remedies which are esteemed most efficacious in such cases were speedily employed, he died two days after. This species, it is said, is no where described, and several naturalists are now employed in examining it. The magistrates of the place have taken proper measures to exterminate this race; a premium of sixty franks is given to every person who kills one of them.

Brugnatelli, in his Annals of Chemistry and Natural History, mentions the two following facts communicated by Dr. Corradori, of Prato, in Tuscany:

A nest of mice being found on a farm belonging to signor Martini, at a little distance from Prato; the young ones were carried to a domestic cat which had just brought forth, and was still suckling her young. The cat devoured them all except one, which she placed near her kittens, and which she suckled along with them. Corradori does not assert that he himself saw this extraordinary instance of attachment, because the mouse had died some hours before he arrived at the spot; but the truth of it was attested by the owners of the cat, and by eye-witnesses. They added that the mouse, faithful to its instinct, removed from the cat, and endeavoured to avoid her caresses: the cat, however, went after it and carried it back to her young. One night, the cat having gone out of the house, the mouse, in consequence of its being deprived of aliment for several hours, was found dead. This fact seems to give a great degree of probability to what the antients so confidently relate in regard to children suckled by wild animals.

The other fact is that of a serpent with two heads, which Corradori saw alive and examined. It was young and in good

good condition; it is now dead (adds he), and preserved in spirit of wine. It had two heads and two necks, consequently four eyes, two mouths, two tongues, and two throats; it ate with both its mouths, but as the will was double, the ideas of the one head were independent of those of the other, and often even they were in contradiction.

It is not improbable that the fable of the hydra had its origin from a serpent of this kind. The fondness of the vulgar for whatever is marvellous, induces them to exaggerate every thing rare or extraordinary, and hence so many fables and prodigies.

HYDRAULICS.

The hydraulic ram of M. Mongolfier has been constructed at Schaffhausen by counsellor Fischer in a very ingenious manner. The machine has the form of a beautiful antique altar, nearly in the style of that of Esculapius, as represented in different engravings. A bason about six inches in depth and from eighteen to twenty in diameter receives the water, which enters into pipes three inches in diameter, that descend in a spiral form into the base of the altar. The water by its weight puts in motion a valve; a third nearly of the water escapes, but the rest by the pressure of the valve is forced into the receiver, and thence rises in very narrow pipes. As it ascends slowly the resistance of the air makes no sensible impression, so that by means of this machine, which continually acts by itself, water may be conveyed from a lake or a river to houses situated on a mountain. M. Fischer has conveyed water by it to a castle which stands at the height of several hundred feet above the level of the Rhine.

WATER-PROOF CLOTH.

It is well known that for some years past several methods have been tried to render cloth impermeable to water, and the inventors of this process have kept the discovery a mystery. There was, however, reason to suppose that some fat oil made the basis of their recipes. A bottle of this liquor, the efficacy of which was known, having fallen by chance into the hands of M. Vauquelin, he was desirous to discover the composition of it. The following is the manner in which this chemist thinks it is composed, bating the proportions. Soap and strong glue, or any other gelatin, are dissolved in water. With this solution is mixed a solution of alum, which, being decomposed, forms in it

a flaky

a flaky precipitate, composed of oil, alumine, and animal matter. Weak sulphuric acid is then added, to re-dissolve a part of the alumine, and to render the precipitate lighter, and to prevent it from falling to the bottom. But the alumine, when once combined with the oil and animal matter, does not re-dissolve entirely in the sulphuric acid; for this reason the oil always remains very opake, and neither rises nor is precipitated. It may readily be conceived, that too large a quantity of sulphuric acid must not be added. M. Vauquelin does not know whether this be exactly the process, but by following it he has been able to obtain a similar liquid, which possesses the same properties.

MISCELLANEOUS.

A knowledge of one of the most fertile countries of Europe has long been prevented by the inaccuracy of the charts and topographical descriptions. A society of engineers, at the head of which is don Salvador de Ximenes, is about to remove this defect. They are now employed, under the auspices of the government, to draw up plans of the principal towns of Spain, and to prepare a general chart of the whole kingdom.

The learned will recollect the notice taken of the *Ignis Græcus*, in a letter from friar Bacon to the celebrated Matthew of Paris. M. le Baron d'Archin, the librarian of the elector of Bavaria, has discovered an old Latin manuscript of the 13th century, which not only imparts the secret, which was supposed to be lost for ever, but speaks of a composition similar to the gunpowder now prepared. An account of it will be soon published; but if we might hazard a conjecture on the subject, it would appear, that this manuscript was a part of the correspondence between the two extraordinary ecclesiastics we have named, of Oxford and Paris.

A person at Petersburgh is in possession of a manuscript in the Russian language, written as early as A. D. 1066. It is adorned with some beautiful miniatures, executed by Grecian artists. The proprietor has refused 20,000 rubles for this valuable relic; and it will be a curious fact, if, from such a source of information, it should be discovered that Russia, the history of which seems to have been involved in impenetrable darkness, should, at the period adverted to, have been the most accomplished and enlightened nation of Europe. Some additional light on that country is expected to be derived from the cabinet of M. Bausse, at the university of Moscow. The first division of that collection

lection consists of medals struck in honour of the czars, with the legends either in the Russian or Tartarian tongues. Most of them are in silver, and of an oval form.

STATISTICS.

In the course of the year 1803 the births at Petersburgh were 3636 males and 3289 females, in all 6925 children, of whom 339 were born out of wedlock, and 10 were stillborn. The deaths were 4578 males and 5044 females, in all 9622. Among this number were 1515 boys, and 1294 girls, of whom 1809 died before their third year, 204 had attained to the age of eighty, 36 to ninety, and 1 to a hundred. It was observed that the greatest number of deaths took place in the months of August and December, and that there were very few in April and September. The number of marriages was 1360; of these 1042 were between young persons who had never before entered into the state of matrimony; 117 between young men and widows; 116 between widowers and young women; 77 between widowers and widows, and 8 after divorces. It has been remarked also, that in this city the two first years of life are more dangerous to boys than to girls, so that in the course of that period the proportion has been five males for one female. The births this year were 763 fewer than in 1802; those of illegitimate children were greater by 93, and the number of the marriages was less by 70.

The following comparative statement of the present population of some of the principal cities of Europe, is extracted from a paper lately read before the academy of sciences at Berlin, by M. Langhans, director of buildings to his Prussian majesty.

According to the author's researches, Berlin occupies a surface of 751832 square perches, and contains 173652 inhabitants, and 6184 houses; London 1176872 square perches, 1035000 inhabitants, 25000 houses*; Paris 1601644 square perches, 700000 inhabitants, 24000 houses; Petersburgh 2112668 square perches, 223000 inhabitants, 5000 houses; Vienna 894448 square perches, 250000 inhabitants, 5000 houses; Amsterdam 460832 square perches, 250000 inhabitants, 7000 houses; Stockholm 463880

* According to the population abstract prepared in 1801 by act of parliament, the inhabitants of London and Westminster amount to 864845, the inhabited houses to 121229, and the uninhabited houses to 5185. Of the houses, 14657 inhabited, and 1088 uninhabited, are not within the bills of mortality. EDIT.

square

square perches, 79600 inhabitants, 5000 houses; Rome 515862 square perches, 163000 inhabitants.

It results from this calculation, if correct, that of all the above cities Petersburgh occupies the largest surface; but in proportion to its extent has the fewest houses and inhabitants. Each individual occupies at Berlin nearly four square perches, at Paris two, at London one and a half, at Petersburgh nine, at Vienna three, at Amsterdam two, at Stockholm five, and at Rome three.

TOADS IN STONES.

A foreign journal states that, at Hellonges, in the canton of Thullen, department of Jemappe, a living toad was lately found inclosed in a vein of pit coal between two masses of rock 600 feet below the surface. It was eighteen inches long, and was found alive, but died as soon as exposed to the air.

LIST OF PATENTS FOR INVENTIONS,

Which have passed the Signet Office, from September 24, to October 24, 1804.

To Samuel Caldwell, of Hathern, in the county of Leicester, frame-smith, and John Heathcote, late of the town and county of Nottingham, frame-setter-up, for their invention of some new machinery and apparatus to be attached or annexed to certain frames or machines called or known by the name of *warp frames*, whereby these frames will work, make, or manufacture, all kinds of thread lace.

To Thomas Noon, of Burton-upon-Trent, in the county of Stafford, watchmaker, for a new thrashing machine with loose beaters.

To Samuel Bennet, of Sheffield, in the county of York, cutler, for a mode of making or casting razors in a new and improved form.

To Robert Barber, of Bilborough, in the county of Nottingham, gentleman, for some new and improved modes of making and shaping stockings and pieces, and also some new and improved kinds of stocking-stitch and warp-work applicable to various purposes.

To James Barret, of Saffron-Walden, in the county of Essex, smith and ironmonger, for an improvement in the construction of malt-kilns, so as to prevent damage from fire, and to save fuel in the drying of malt.

To Jacob Buffington, of the city of Bristol, gentleman, for a new method of straining or stretching (technically called *habiting*) all kinds of woollen cloth for cropping or shearing, and for straining all other kinds of piece goods.

METEORO-

METEOROLOGICAL TABLE*
For October 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Sept. 27	50°	61°	52°	30·35	26°	Cloudy
28	52	58	51	·35	25	Cloudy
29	50	58	50	·20	16	Small rain
30	49	59	57	29·99	10	Cloudy
Oct. 1	57	64	58	·88	15	Rain
2	55	64	60	·92	15	Cloudy
3	62	66	56	·95	25	Fair
4	52	63	60	·95	30	Fair
5	56	62	47	·72	41	Fair
6	47	61	57	30·14	45	Fair
7	57	60	55	29·95	18	Showery
8	48	58	46	·78	26	Fair
9	46	55	43	·94	50	Fair
10	40	55	53	30·11	15	Rain
11	56	58	46	29·52	5	Rain
12	48	54	42	·32	15	Showery
13	37	51	46	·50	19	Fair
14	47	57	51	·30	33	Fair
15	48	55	42	·29	48	Fair
16	40	54	43	·67	40	Fair
17	47	58	47	·68	25	Showery with thunder
18	48	58	52	·95	21	Rain
19	53	60	55	·98	30	Fair
20	56	63	54	·90	25	Fair
21	54	59	54	·71	10	Cloudy
22	55	56	47	·41	14	Rain
23	46	56	47	·60	30	Fair
24	45	52	49	·78	21	Fair
25	49	51	49	·80	17	Cloudy
26	49	57	48	·77	14	Showery

* By Mr. Carey, of the Strand.

XV. *Letter from Dr.* MITCHILL, *of New-York, Representative in Congress, &c. to* BENJAMIN MOSELY, *M. D. &c. containing some interesting Particulars in the History of Muriate of Soda*.*

New-York, 1st July, 1804.

THERE has been an opinion propagated of late, that sea-salt taken with food is injurious to animal life. It is pretended that when used as an article of diet it acts merely as a stimulus, without affording any nourishment. A fossil and unnatural substance received into the stomach must, it is asserted, be productive of debility and disease. The employment of it has been ascribed to caprice, and scurvy and scrophula are alleged to be the consequences of an habitual indulgence in it.

There is strong reason to doubt the correctness of this doctrine. The universal and instinctive appetite of man for salt seems rather to arise from a constitutional want; and the supplying of this want, in a moderate degree, appears to be conducive to his well-being. Instead of receiving salt into the stomach through mere whim, mankind are governed, in mingling it with their food, by a steady and wholesome principle. But lest some ambiguity should beset this inquiry if the human species were alone attended to, it will be easy to adduce arguments from the history of brute animals in favour of the friendly operation of salt upon their living bodies. And if these creatures, who eat it through instinct, and not by caprice, are benefited by it, there will be thence derived a close analogy to evince its wholesome operation upon man.

Among nations who live near the ocean, where common salt is plentiful, and where the atmosphere is charged with its briny particles, much is indeed known of it as an article of manufacture. By them its history, as a subject of commerce, is well understood. So likewise the method of taxing it, for the purpose of raising revenue, has been pursued to a great length; and chemists have laboured to decompose it economically by a variety of torturing processes.

But there are some facts concerning the muriate of soda which are afforded only by countries that are situated far from the ocean, and containing very few springs, mines, or mountains of salt. Where this material does not abound in the earth or the waters, and where, of course, the neigh-

* Communicated by the Author.

bouring atmosphere is in no degree impregnated with it, a number of facts occur concerning the eagerness with which wild and domesticated animals devour this refreshing material.

Wherever, by an indulgent provision of nature, the muriate of soda is found in the soil of the interior parts of North America, thither the wild beasts of the forests are invited, by its diffusive and savoury qualities, to regale themselves. The volatility and odour of salt in the atmosphere is such, that a man travelling from the interior country toward the sea-coast, can very distinctly smell the saline impregnation at a considerable distance. It is believed upon the strongest grounds that brute animals are affected by a similar sensation. But such of them as pass their lives in a maritime air, become soon insensible of the salt which surrounds them, although they are apparently imbibing it in considerable quantity. In islands and regions along the ocean, this process of absorption, whereby salt as well as water is taken into the constitution, seems to be continually going on. They, therefore, who make observations and experiments in a maritime atmosphere, would do well in their publications to make too some allowance for the muriatic tincture of it.

The spots of the inland country where salt exists, either in the soil or the springs, are frequented, as was observed, by the beasts of the forests. They apply their tongues to the earth so impregnated, and gather as much as will supply their wants. The spots thus resorted to are called *licks* or *licking-places*. Some of these *licks* are dry; but the greater number is moist, the water either slowly oozing out, or bursting forth in springs. Both the earth and the waters are charged with different quantities of salt, from the most trifling portion that the acute taste of a wild creature can distinguish, to an impregnation of greater strength, and even to a tolerably strong brine.

The animals which frequent these *licks*, for the purpose of salting themselves, are deer, elk, and bison (miscalled the buffalo). Their bones are frequently found in the muddy and wet places around or near them. It is not known that carnivorous beasts, such as wolves, panthers, or wild cats, ever visit the *licks* for the purpose of regaling themselves with salt; their only object is to seek prey among the creatures who go there for that purpose: and to the destruction of the weaker graminivorous brutes by the more ferocious ones who devour flesh, is to be ascribed a part of the collection or stratum of broken skeletons which abound

thereabout.

thereabout on the surface of the ground and below. And the reason why the beasts of prey have so little appetite for the muriate of soda seems to be, that they obtain a substitute for it in the phosphate of lime, which constitutes a principal part of the bones of the animals they feed upon. For it is remarkable, that flesh-eating quadrupeds cranch and swallow much of the bony as well as of the soft parts of their prey. The alkaline quality of the lime thus appears to produce a salutary effect in their stomachs and intestines, equivalent to the operation of the soda in such creatures as are nourished by vegetable food. A wolf does not content himself with devouring the flesh, blood, and entrails of the sheep; his repast is not complete unless he gorges himself with the principal part of the bones too: but the harder and larger bones of deer, elk, and bison, are often left unconsumed by the wolf; and therefore remain to undergo disorganization in the common way.

The appetite of these creatures for the muriate of soda is so strong, that when they are obliged to lick a great quantity of earth to obtain a trifling proportion of salt, they receive more injury from the former than benefit from the latter; their health suffers; and the infirmity under which they labour is to be ascribed to *dirt-eating*. It is believed that wild animals have often been killed by finding a plenty of salt water at the *licks*, and swilling it down too greedily; as domestic animals have been often known to die in consequence of taking suddenly an over-dose of salt. Rushing from the pasturing- and browsing-places to the saline waters, and feeling an ungovernable relish for them, the deer, elk and bison are supposed frequently to have drunk themselves to death. To this cause is another portion of these bony relics at the *licks* to be ascribed.

The facts are well remembered, that at the *Blue-Licks* in Kentucky, where the water had a more than common portion of salt dissolved in it, the resort of wild creatures was so great when that region was first visited by white men, that the immediate vicinity of the *lick* was trodden to mud, and resembled a vast clay-pit where mortar is prepared for the brick-makers; such was the innumerable crowd pressing and circling round and round to get an opportunity of tasting. Some of the weaker of these have been trampled under the feet of the stouter, and killed on the spot. Many more have been arrested in the mire of their own making; and, with their legs surrounded by the deep and stiff mud, they have strained and wallowed until they died. These are other causes of the abundance of bones, especially of

G 2 bisons,

bisons, which are discovered under ground thereabout. The resort was so numerous, that for a space of nearly two miles across there was not a single herb or plant to be seen. Like other yards or places much frequented by cattle, every green thing, even the forest trees, had been destroyed. Beyond this spacious area the roots of many trees had been laid bare and bruised by the stampings of their feet, as happens at the posts and sheds where horses are tied and tormented by flies. So long continued and incessant had been the treading, scraping, and stamping, that many of these trees, undermined at their roots, had been blown down; and for several miles around this great place of rendezvous, all the herbage and shrubbery had been cropped off and eaten away.

The bones of the unknown, and probably extinct, species of elephant, called the mammoth, have been found plentifully at the *licks*. The death of so many of those huge creatures in the neighbourhood of the *Salines* is a subject of various conjecture:—they might have travelled to those spots for the purpose of salting themselves, like other herbivorous animals; and when there, they might have been destroyed by means similar to those which proved fatal to the smaller beasts; such as drinking excessively of the salt water, dirt-eating, destruction by their natural enemies, or getting bemired and cast in the mud-holes and sloughs. It is probably owing to a conjunction of all these causes that this extraordinary race of quadrupeds has disappeared from the land of the living. The occurrence of so many elephantine bones near Newburgh in New-York, at the bottom of marle-pits, gives countenance to the supposition that the mammoths expired in the mire of the places to which they went for drink.

But the muriate of soda is sought and devoured with equal eagerness by tame animals as by wild ones. Neat cattle, sheep, and horses, are remarkably fond of it; and it is even relished, though in an inferior degree, by swine. Those creatures, however, it must be remembered, when they live near the sea-coasts and in insular situations, immerged in a saline maritime atmosphere, do not acquire a very keen relish for salt. It seems, as was before hinted, that their bodies inhaled it from the air, which is known frequently to contain so much of it as to bedew the leaves of trees, and the blades of grass, with a briny sprinkling. They may thus take it in with their food as they graze on the uplands, and more particularly when they are fed with salt fodder.

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In the interior parts of the American continent where salt is scarce, or does not exist naturally at all, and where no saline quality is imparted to the atmosphere by the lakes of fresh water, the condition of domestic animals is very different; they pine for want of this stimulus, and their suffering and leanness are not confined to such kine, sheep and horses as may have been carried thither from the neighbourhood of the ocean, but obtain in those which have been raised in inland situations, and have never been accustomed to the influence of a maritime atmosphere.

Thus this appetite for salt would appear to be instinctive; and from the following facts it can scarcely be denied to be highly nourishing and wholesome, whatever speculative men who live and write near the ocean may allege to the contrary.

Experience has proved that cows do not give so much milk when they are denied an allowance of salt as when they are supplied with a due proportion of it. This is so notorious, that the wives of farmers who keep dairies can discover, by the lessening of the quantity of milk, that the cows are in want of salt; and this shrinking takes place merely from the withholding of the salt, although the water-pasture and other circumstances should remain the same.

Not only does the milk of cows vary in quantity, but undergoes a change in quality, by the operation of salt on their constitutions. The milk is thereby rendered more apt to curdle; less cream rises on its surface; and it is better adapted to the making of cheese. The cheese-makers of the interior country find that the salting their cows is an important matter in the dairy process; and it has been supposed that insular situations, such as Block-Island, Great Britain, &c. &c. were indebted for the excellence of their cheese, partly to the saline quality of their atmosphere.

The calves of cows treated with muriate of soda are better nourished and more thrifty on that account. It is sufficiently understood that they make a more vigorous and handsome stock.

So much for salt as respects the dairy.—Its effects are scarcely less considerable in fattening oxen and other neat cattle, and preparing them for the butcher. Without salt, give them as much hay, pasture, and grain, as you please, and they remain meagre and unthrifty. To make the fat accumulate in them, and to give them plumpness and rotundity, it is necessary to treat them with muriate of soda. Its operation is so beneficial, as well to reward the owner for his

 expense

expense and trouble. Stall-fed oxen require salt once at least in two or three days in the state of Vermont.

The usefulness, yea even the necessity of salt for domestic animals is so great and so universally acknowledged, that every farmer living remote from the saline effluvia of the ocean finds it to his interest to purchase a quota of salt for each head of stock that he possesses, and to incur considerable annual expense for that purpose. And this article is found to be almost as much wanted by the brute ani- of the plantation as by the human beings of the household.

The greediness of these domesticated creatures for salt is such, that when it has been withheld from them a longer time than usual, they can smell it from the hand or pocket of a person who enters a field, to a considerable distance: they crowd round him with such earnestness as sometimes to put him in danger of being pushed and trampled down, or of having his clothes torn off his back. They lick the dust that is tinctured with the most trifling particles of salt, and gnaw and devour clothes, leather, and every thing whatever that contains the minutest portion of it. And in case there should be no sea-salt, they will greedily regale themselves with the saline remnant of potash and soda adhering to goods that have been soaked in ley, or washed with soap; in this respect manifesting an appetite similar to that of the human species, who, both in America and Asia, employ vegetable ashes as a condiment for their food, when they are unable to get a supply of common salt.—See Medical Repository, vol. vi. p. 330, and Philosophical Magazine, number lxv. p. 18.

If it should be demanded what is the final cause of this unconquerable desire for salt, it might be replied that, besides stimulating the mouth and alimentary canal, salt evidently acts as a corrector of putrefaction upon the food and fæces therein contained, and by furnishing a supply of soda to preserve the bile in an alkaline and antiseptic condition. In my theory of the operation of common salt in preserving animal flesh (Med. Repos. vol. ii. p. 210), I have supposed that both the meat and the salt may undergo a decomposition. When this happens, the corrupting meat sometimes forms septic acid. This product of putrefaction decomposes the salt, in consequence of a strong attraction for its alkaline basis, soda, and forms a septite of soda; while the disengaged muriatic acid combines with the beef, mutton, or whatever it may be, and forms a muriate of meat.

meat. Thus the septic acid, which is a nauseous and unhealthy thing, is neutralized, and the muriatic acid, which is savoury and wholesome, is substituted in its place.

So likewise, as experiments have shown that the gall of even herbivorous and graminivorous animals contains soda, there is an easy method of explaining whence that peculiar fluid gets its alkali. Either the liver must be a manufactory of soda, from its constituent atoms or ingredients, or it must be an organ separating and collecting that alkali from the blood. The latter is the easier conjecture; and probably, as the appetite for salt supplies the blood with a sufficiency of that material, one of the functions of the great biliary gland may be, to decompound as much of it as is necessary to constitute an alkalescent, antiputrescent and healthy bile. The learned and ingenious works you sent me have afforded me much instruction; and I am highly pleased with the free and liberal remarks on pestilential distempers which your letter contained. As the origin of those calamitous occurrences can only be well understood by attending to the history and effects of alkalies, you will instantly perceive the reason why I have written you so long an epistle on that neutral compound, which is formed by the union of one of them with the muriatic acid.

Yours truly, &c.

XVI. *Biographical Memoirs of* Peter Francis Bernier, *who accompanied Capt.* Baudin, *as Astronomer, on his Voyage of Discovery. By* Lalande.

P. F. Bernier was born at Rochelle, on the 19th of November 1779. His father, who had lost his place,—that of an intendant,—did every thing in his power to prevent the education of his son from being neglected. During seven years he kept him under the care of a master, who discharged his task so well that his pupil, when he attained to his fourteenth year, had made considerable progress in Latin and other branches of study. He procured for him also private instructors in the mathematics and music. His friend Ingres, who was afterwards a distinguished pupil of David, taught him drawing. In his literary pursuits and recreations he soon displayed a manly character, and associated only with young men fond of knowledge, with whom he conversed on subjects of science. In his fifteenth year he delivered an oration, in a public assembly, on filial piety, which was written with so much interest and feeling that it

was received with universal approbation. To avoid being a burthen to his parents, he engaged himself with an attorney; but a decided attachment to the mathematics induced him to employ the whole of his leisure on the study of them, and to expend all the money he earned in the purchase of mathematical books. He learned also the Italian, and the art of stenography. Fortunately he found in Duc la Chapelle of Montauban a distinguished patron, who was able to assist him both by his talents and property. The Abridgment of Lalande's Astronomy, which he obtained from this friend, caused in his mind such a taste for astronomy that Duc la Chapelle gave him admission to his library and observatory. Nothing more was wanting to make him devote himself entirely to that science. In a short time he made himself acquainted with astronomical calculations; and, after a little practice at the observatory, Duc la Chapelle found his observations so accurate that he intrusted him with the use of his best instruments. On the 26th of April 1797 he transmitted to Lalande the result of his first observations and calculations, some of which were published in the *Connoissance des Tems* for the year 11. As the confined state of his finances, however, did not permit him to bestow his whole time on astronomy, and as his parents founded all the hopes of their declining years on his talents and affection, he resolved to offer himself as a candidate for the polytechnic school. For this purpose he repaired, at the appointed time, to Toulouse, and was examined by Monge on the 16th of October 1797. Soon after Lalande invited him to Paris, where he arrived on the 31st of January 1800, and now became a complete votary of astronomy, so that Lalande hoped to obtain him as a new assistant. The preparations then making, however, for a voyage of discovery presented to his desire of distinguishing and making himself known so captivating a field, that, with the concurrence of his parents, he resolved to take advantage of it. On the 22d of September he proceeded to Havre, and on the 19th of October the expedition sailed. During the first days after being at sea, M. Bernier was exceedingly sick; but in a letter, dated from Teneriffe on the 2d of November, he announced that he no longer felt any inconvenience from the motion of the ship. When he arrived at Timor, he sent home a second letter, dated October 14th, 1801. He had already accustomed himself so much to observing on board ship, that he was certain of the longitude to ten minutes; and after a stay of three weeks on that island, he was able to determine it within nearly a minute.

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He examined the nature of refraction, and hoped to be able one day, in the north, to solve all those doubts which are still entertained respecting it. He endeavoured to improve all those instruments used at sea; made observations on magnetism, the northern lights, the flux and reflux of the sea; and, that he might observe with more convenience, he caused a tent to be erected on the shore. He wrote also a vocabulary of the language of Timor, from which it appears that the inhabitants styled Bonaparte the *Great Son of the Crocodile.* Berthoud's marine time-keepers were of great use to him: in a letter which he wrote to Lalande, at Port Jackson, he said—"These time-keepers are wonderfully accurate and regular; assure that admirable artist of my esteem and respect."

The expedition sailed from the Isle of France on the 25th of April 1801. On the 29th of May they got sight of the coast of New Holland, opposite to Cape Lewin in the south-west. They ran down the coast for four hundred leagues, landing at the most important points, and determined the Bays of the Geographer and of Seals; but, in consequence of the scarcity of water and fresh ptovisions, were obliged to return to Timor, where they arrived on the 23d of August, 1801. On the 14th of November they proceeded again for New Holland. "Here I saw, for the first time," says Bernier, in a letter to Lalande, dated November 17th, 1801, "the interesting inhabitants whom we call savages, and who live as nearly in a state of nature as can possibly be imagined: should I have the pleasure of seeing them again, I shall give you some account of their manners and customs. I was a witness of their melancholy and precarious state of existence; I found them to have no shelter against the heat and the cold." In the year 1802 the navigators proceeded to the south-east part of Bassa's strait and Port Jackson. Bernier observed a solar eclipse on the 4th of March, an eclipse of the moon on the 19th, and the transit of Mercury over the sun's disk. On the 9th of November, captain Flinders, who commanded a similar expedition sent out by the British government, observed the solar eclipse at land, on the south-west coast, at lat. 38° 48′, and long. 53° 49′, reckoning from the first meridian; the commencement at 1^h 12′ 37″, the end at 3^h 36′ 11″. On the south coast two large gulphs were explored. On the third cruize, they sailed from Port Jackson; completed the survey of the south coast; proceeded west, and endeavoured to approach the north coast, which, however, has been still inaccessible. Captain Baudin then wished to visit

visit Carpentaria, but was prevented by a south-eastern gale, on which account he returned to Timor. Bernier, who had long been struggling with bad health, when he arrived here found himself exceeding weak; he was seized with an inflammatory fever, the consequence of bad weather; yet he again went on board the vessel in the beginning of June, but died a few days after. His death is a real loss to astronomy, as well as to all his acquaintance. Though a youth, he displayed all the experience and reflection of maturer years, and distinguished himself as a dutiful son, a sincere friend, and an useful citizen.

XVII. *Account of the Voyage undertaken by the Spaniards to the North-West Coast of America in the Year* 1792.

[Continued from page 14.]

The writer who drew up the account of this expedition acknowledges that the only result of it was, to ascertain, in a decisive manner, that there is no passage into the Atlantic through the strait of Fuca. But this navigation must in future appear as useless as it is uninviting. The barren and desolate coasts by which this strait is bordered, present nothing that can induce navigators to expose themselves to the dangers of a long voyage, through narrow channels interspersed with quicksands and shoals. The philosopher only, adds he, can find here subjects for meditation, when he beholds a soil which reminds him of the primitive state of the globe, and tribes still far removed from the civilization of Europe, different in their manners, though inhabiting nearly the same climate, though devoted by necessity to the same kind of life, and having, in all probability, been exposed to none of those revolutions which alter the type of what men have agreed to call *nature*.

The Spaniards saw them in too fugitive a manner to ascertain whether they differ in their language as they do in other things. The only satisfactory results obtained on this point relate to the Indians of Nootka, with whose language they made themselves pretty well acquainted. A man of letters, Don Francisco Mosino, who accompanied captain Don Juan de la Bodega, of Quadra, resided a long time among these Indians, and observed them with attention. It was to him in particular that the Spanish navigators were indebted for the details which they at length resolved to publish, and particularly those in regard to the language of

Nootka.

Nootka. According to Mosino, this idiom is the harshest known; it abounds with consonants and *sourdes* terminations: most of the words are pronounced with a strong aspiration at the commencement and in the middle. The following examples will serve to give some idea of it:

The year	-	*Yachinic shitlé.*
A young woman	-	*Ag-coatl.*
An old woman	-	*Mitouc-cloutzma.*
An ugly woman	-	*Pizoul-clouzma.*
A beautiful woman	-	*Tloul-clouzma.*
A child	-	*Maetl-catzis.*
An old man	-	*Moutong yacops.*
Lame man,	-	*Quouils-zac-tle.*
The beard	-	*Apac-tzoutl.*
The hand	-	*Coucou-mitzou.*
The thighs	-	*Apesouh-tatchi.*
The belly	-	*Ic-tac-tlas.*
Sweet	-	*Hoptzé-machitl.*
An apple	-	*Mou-mou-octl.*
Smoke	-	*Ish-cuits.*
The shoulder	-	*Inapatl.*
Sand	-	*Morec-cou-metz.*
A flower	-	*Coï-matz.*
A dog	-	*Aemitl.*
To throw	-	*Huaschitl.*
To swallow	-	*Chtt-tzitl.*
To drink	-	*Nec-tzitl.*
To sweep	-	*Hz-etzitl.*
To sneeze	-	*Toupex-chitl.*
To sigh	-	*Hitl-tzitl.*
To bite	-	*Muchitle.*
To pour out	-	*Tzi-chitl.*
To-day	-	*Tup-chitl.*
To-morrow	-	*Amiestla.*
The last	-	*Tlaeztztl.*
Ahac ammatce sua	-	What is your name?

With a language so inharmonious, manners so simple, and so little progress in civilization, it may readily be conceived, that the music of the Indians of Nootka must be rude and artless: they are, however, fond of singing, and all their concerts are vocal; their concords are only octaves, and by way of accompaniment, their singers beat time on boards with the first solid body they can find. To this kind of continued bass they join the noise of a sort of wooden castanets.

castanets. Their organs are not sufficiently delicate to relish our European music; sweetness of tone makes no impression on their senses; according to their taste, music, to be agreeable, must be noisy and produced by great efforts: one of their chiefs, hearing the Spaniards play on their instruments, said to them, "This music cannot affect us; it is like the singing of birds, which recreates the ear without touching the heart." Another ridiculed their cadences, and the whole of their music in which the soft languor of flats prevailed; he said of the performer, "One would think he were shivering with cold;" and to the singer on the flat key, "He sings like a man half asleep."

Their balls are a kind of figured combats, in which they appear armed with bows, arrows, and fusees, sometimes disguised as bears and stags, or covered with masks and coarse dresses, which give them the figure of aquatic birds, larger than nature, the motions of which they endeavour to imitate; while others counterfeit hunters who are watching for and pursuing the supposed game. At other times they dance ballets, the pantomime of which, too easy to be understood, would scandalize the least scrupulous European; some of these ballets are so obscene, that we would not offend decency by attempting a description of them.

The Indians of Nootka have different confused methods of counting the days and the months. Those whose minds are more cultivated divide the year into fourteen months, of twenty days each, adding some complementary days at the end of each month.

In general all these people announce a good natural disposition; they are sensible to friendship, and susceptible of gratitude; they are not deficient in understanding; they readily comprehend what one intends to say to them, and they invent ingenious methods of making themselves understood. They are benevolent, and do actions of kindness with great delicacy: Macuina, knowing one day that the Spanish commandant was in want of provisions, sent orders to his mischimis to give him, without payment, all the fish they might catch; and having observed that the Spaniards could not easily dispense with the use of flesh, he sent them a stag every week. He was never more assiduous in his attention to them than when he saw them in want. Quadra, who spent a whole summer with Macuina, bestows high praise on the kindness of this chief, and the security he enjoyed both from him and his people: Macuina often slept soundly in the alcove of the Spanish commandant, as if he had been under the protection of a friend or a

 brother.

brother. When any of these Indians were surprised by night in the habitations of the Spaniards, they asked for torches to enable them to return to their huts, and sent them punctually back the next day. Their fidelity in discharging their promises was carried to the most scrupulous rigidity: the following is a striking proof of it:—one of their chiefs, whom the editor calls prince Natzapé, had asked from the Spaniards plates of copper and other articles of exchange, with which he intended to procure otter skins among a neighbouring tribe, separated by an arm of the sea. In the passage his canoe foundered, and poor Natzapé lost his wife, with every thing he possessed, and all that he had borrowed. He supported his misfortunes with wonderful constancy; and having wept for his companion some time, he began to work till he had paid the whole of what he owed.

The Spanish vessels left Nootka on the 31st of August 1792, to explore the coast from the strait of Fuca as far as Monterey and Saint Blas; that is to say, for the space of twenty-eight degrees. The Spaniards seem to be very well acquainted with all this part of America. On the 20th of September they anchored at Monterey, the position of which they had accurately determined the preceding year, in lat. 36° 35′ 45″, and long. 115° 47′ 30″ from the meridian of Cadiz. The shore of Monterey, besides other curiosities, contains a great abundance of very beautiful shells, known to naturalists by the name of *aliotismyde*; they are found only on this coast and on that of New Zealand; some of them are remarkably large; the index and thumb of both hands, when made to touch, can scarcely comprehend them. They are lined on the inside with a covering of mother-of-pearl, veined with the most beautiful azure.

The fort of Monterey, which is the principal settlement of New California, has a garrison of only sixty-three soldiers, who, for want of tradesmen, are obliged to exercise all kinds of mechanical occupations. A law which cannot be explained, much less excused, prevents them from building houses and cultivating the land. Two leagues from Monterey is the mission of San Carlos, which has effected a kind of miracle, by civilizing the Indians in the neighbourhood. This is one service more rendered by religion to mankind; for the civilized Indians are sensibly more happy than those of the same canton who continue to wander through the woods, or to sail about at random in their canoes. Though apparently stupid, they are, however, susceptible of instruction; they have a wonderful dexterity in

in attracting towards them and killing wild beasts, by clothing themselves in their skins.

The editor here stops to give an account of the benefits which his countrymen have diffused over these little known coasts. He takes a view of the missions of New California, which extends from Port Saint-Diego in about lat. 33°, to Cape Mendocina in about 40°. These missions amount already to twelve; but the most populous has only about twelve hundred colonists: they enjoy at least the first physical advantages of civilization; they breed cattle, cultivate vegetables, and collect different kinds of seeds. These occupations lead to a settled kind of life, which, with the lessons and example of the missionaries, tends gradually to soften the manners of these Indians.

Every thing, however, had not yet been done which might be accomplished in this respect; the efforts of the missionaries have only been able to make them lay aside a part of their savage habits. The men and the women, for example, go entirely naked, and run about indiscriminately in the fields with the brutes in search of food. They are still, in regard to modesty, what they were formerly described to be by father Venegas; who said of them, "that to see one of their people clothed, appears to them as risible as an ape in clothes would appear to us." In many respects they are still but children of a greater growth; their wars are short, but renewed on the slightest occasion; their primitive religion seems to be as deformed as every thing else relating to their moral existence; one must look very narrowly to see any of their rites or their dogmas.

Two tribes of these Indians have in particular engaged the attention of the Spaniards: these are the Runsians and the Eslenes, which resemble each other only in some points. Both of them admit polygamy; but among the one the punishment of adultery is inflicted, not on the woman, but on her seducer, who, according to the nature of the case, and perhaps the degree of the husband's resentment, is exposed to severe wounds which may prove mortal, or only to be well cudgelled. Among the Eslenians the injured husband contents himself with repudiating, at least for a certain time, his unfaithful spouse, or abandons her to the seducer at the price he himself gave for her. This custom of purchasing their wives is common to both these tribes; in both the women are remarkable for their affection to their children; they are prolific and robust. It is not uncommon to see them resume their usual occupations some minutes after delivery; but, as in many other parts of North

America,

America, the husband is nursed for some days after his wife has brought forth. Among the Runsians homicide is almost considered as a matter of indifference; but among the Eslenes it is punished with death. Both tribes observe nearly the same funeral ceremonies; but among one of them, whatever property is left by the deceased is divided among his relations; among the other, all the friends bring, as a farewell offering, some articles of furniture, which are interred with him.

It is very remarkable, that two tribes so near to each other and so similar in some respects should be so different in others: this difference is particularly remarked in their languages; between which the ablest etymologists would scarcely find the slightest relation.

XVIII. *Osteological Description of the one-horned Rhinoceros, by* Cuvier.

[Continued from our last volume, p. 354.]

2d, *The Teeth.*

A knowledge of the number and position of the teeth, but particularly of the changes which take place in their figure at different ages, is of the greatest importance in the study of the nature of animals in general, but especially in researches respecting those species to which the fossil bones have belonged. I have therefore paid more attention to this part than to any other.

This was necessary in a particular manner in regard to the rhinoceros. The want of proper observations had occasioned a variation among naturalists in this respect; and M. Faujas, the last person who examined it, has only increased our doubts: a regard for truth has induced me to rectify what he has said on this subject.

My observations are the more necessary, as this learned geologist had deduced, from facts seen in a wrong point of view, conclusions subversive of those bases on which the systems of zoölogy are founded. But those who are not in a situation to verify the facts in question; and who, on the other hand, are unacquainted with the rational foundations of our systems, may too readily adopt conclusions advanced by a naturalist of so great authority, which would remove still to a greater distance the epoch when the real principles of zoology will be universally acknowledged.

I shall observe then in general, that all the rhinoceroses have seven molar teeth on each side, both in the upper and lower jaw, making twenty-eight all together.

The

The head of the two-horned rhinoceros in our museum exhibits indeed only twenty, apparently on account of the age of the individual to which it belonged: but anatomists are not deceived in these cases, because they know how to find in the cells at the bottom of the jaw-bone, the germs of the teeth which have not yet appeared; and these germs have really existed in this head, which would have had twenty-eight teeth, like all those of its species, had not the animal been killed too young.

The skeleton of the one-horned rhinoceros, which forms the principal part of the present description, exhibits also, it is true, on one side of the lower jaw six teeth or stumps of teeth, and on the other seven; but this is only an appearance which cannot deceive when one has studied the laws of the growth of teeth, especially according to the method of Tenon.

All herbivorous animals, beginning with the horse, wear their teeth to the very roots, because, in proportion as the crown is diminished by trituration, the alveolus fills up and pushes the tooth outwards. When this root is composed of two branches, as in the rhinoceros, and the shank of the tooth is completely worn, there remain two stumps of the root: these stumps drop out one after the other, always lessened by trituration and pushed outwards by the increase of the bone in the interior of the alveolus. At length, however, the alveoli themselves become entirely effaced.

This is what in part took place in the rhinoceros in question. It had already lost its two molar teeth, and the alveoli were almost entirely effaced; the detrition of the two following ones had been extended to the roots, and it had even lost on one side one of the stumps of the roots, while those of the other side both remained.

Besides, no animal has nor can have an odd number of teeth, considering the symmetry of the sides of the head, and the suture which dividing the maxillary bones prevents them from having an alveolus in the middle. Thus, when one tooth more is found in the one side than in the other, one is added in imagination to the latter.

But if this rhinoceros had lost its molar teeth by age, it had not gained incisors. This is not the case with it, nor with other animals which grow old. The two small intermediate incisors of the lower jaw exist at a young age, as is seen by the head given to the cabinet of M. Adrian Camper; and still better by the end of the lower jaw of a very young subject drawn by his father, and inserted in the Transactions of the Imperial Academy of Sciences at St.

St. Petersburgh for 1777 *; but they remain at all times concealed under the gum, and this is the reason why Meckel did not see them in the living animal, while they showed themselves in the skeleton. Mr. Thomas, a surgeon of London, who has published some anatomical observations on the one-horned rhinoceros, also found these small teeth in the skeleton of an individual four years of age.

But what no one, as far as I know, has ever yet published is, that the rhinoceros, during a certain period of its life, has two similar incisors in the upper jaw, only they are without the large ones, while in the lower jaw they are among the large ones. This, indeed, might be concluded from the drawing of the intermaxillary of the very young rhinoceros given by Camper the father in the Transactions before mentioned †. I even at first conceived that these bones must necessarily have been produced by another species.

But on examining the anatomical drawings of our rhinoceros, made with the greatest care by Marechal under the inspection of Viq-d'Azir and De Mertrud, I observed the figure of a very small tooth without the large upper incisor of the right side; and I saw in the explanation which accompanies that drawing, and which is by Viq-d'Azir, that there was indeed on that side a small tooth which was wanting in the other. I examined the skeleton, and found on one side the remnant of an alveolus, but the tooth, already too much extirpated, had been lost at the time of maceration; on the other side the alveolus even had been effaced.

It may be readily seen that all these observations prove nothing against the importance which characters taken from the teeth have in zoölogy; but to employ their number, for example, as a character, we must no doubt take the proper precautions to ascertain what it is, and in general to obtain all the preliminary knowledge that may be necessary. One will not then be in danger of creating species which never existed,—a fault which would be attended with as bad consequences in the simple history of animals and in its systems as in geology; for, if natural history requires truth, it is above all in those parts which are entirely conjectural ‡.

After this necessary digression I shall return to my subject, and continue to describe the teeth of my rhinoceros.

To obtain a complete knowledge of the teeth of herbivorous animals, it is not enough to have seen them at one period of life, as these teeth are continually wearing down; the figure

* Plate ix. fig. 3. † Plate Ix. fig. 2.

‡ See Essais de Géologie de M. Faujas, vol. i. p. 193—196.

of their crown is also in a continual state of change; and the naturalist must follow them from the moment when they pierce the gum to that when they fall out of the mouth.

But it is not always necessary for this purpose to have at one's disposal individuals of all ages. As the fore-teeth appear sooner, they are also sooner worn; and one may often follow in one jaw all the degrees of detrition proceeding from the posterior to the anterior teeth.

The following, then, are the appearances observed in the teeth of the rhinoceros:—The base or neck of the tooth is quadrangular; the interior and posterior side are a little shorter than the anterior and exterior; consequently the latter intercept an acute angle, and the others an obtuse. On this base, supposing the side of the root turned down, arise eminences the summit of which is sharp and entirely covered with enamel. As long as the tooth is not worn, one of these eminences fits exactly the exterior edge of the tooth, or rather forms it: it has a vertical rib projecting towards the anterior third.

The second eminence is towards the anterior edge: it is joined to the first at the anterior external angle; then inclines towards the interior anterior, but proceeding a little more backward than the anterior edge of the base.

The third eminence arises from the posterior third of the first; proceeds directly inwards, then bifurcates: one of its branches proceeds forwards and the other obliquely backwards towards the interior posterior.

These sharp eminences, at a considerable distance from each other at their summits, have broad bases which touch each other. The first effect of detrition is to wear off the enamel from the summit, and to discover every where a line of osseous matter bordered with two lines of enamel. In proportion as the detrition increases, and descends to the thick part of the eminences, the length of the osseous part increases, and that of the hollows between the eminences decreases. When it advances still more, the anterior hook of the third eminence joins itself to the second, and there remains a round hollow towards the middle of the tooth; a little later another branch of the third eminence unites with the posterior edge of the tooth, and there remains a second hollow behind: these two transverse eminences then unite at their interior extremity, and leave between them a large oval and oblique hollow in the fore part of the tooth. In the last place, when detrition has proceeded to the base of the eminences the hollows themselves disappear, and the crown then exhibits a smooth surface of osseous matter surrounded by a border of enamel.

One

One may follow these different states in the figures of Plate I.*, one of which exhibits the teeth of a two-horned rhinoceros still young, the other those of an adult unicorn. One may follow there also the variations of the molar teeth downwards, which are much less considerable.

They are composed of two eminences turned round in the form of a portion of a cylinder, and placed obliquely one behind the other, in such a manner that their concavity is turned inwards and a little forwards. The detrition only enlarges the crescents of their summits; but this figure of a double crescent is preserved until the eminences are worn at the base, a period when the tooth becomes quadrangular and single.

It was for want of being well acquainted with this variation of the teeth by detrition, that Merck, to whom, however, we are indebted for the first efforts to illustrate this part of the natural history of the rhinoceros, thought himself authorised to advance, in his third letter on fossil bones, a fact which Faujas inserted in his *Essais de Geologie* †. This fact is, that fossil teeth of the two kinds of the living rhinoceros are found in Germany.

But, even allowing this fact to be true, it would be impossible to prove it, because the teeth of these two species resemble each other when they are of the same age; but Merck had in his possession the head of a young two-horned rhinoceros: all the fossil teeth, which resembled those of this head, were considered by him as coming from the two-horned rhinoceros, and those which were advanced, from the one-horned.

In reality, these teeth came neither from the one nor the other, as I shall prove hereafter, but from a third species, which differs from the two first in other respects than by the teeth.

We have given in Plate IV. specimens of these fossil teeth of the rhinoceros. It will there be seen, that, without the rules which we have established from observation, every body would be tempted to ascribe them to animals very different.

Fig. 1. represents a superior molar tooth of the right side, very much worn: the original is in our museum.

Fig. 2. exhibits a portion of an upper jaw with two teeth, one of which is entire and still untouched. This fragment, in the cabinet of Joubert, was found near the village of Issel, on the last declivities of the Black Mountain. The individual must have been of a small size.

* Given in our last Number.

† Vol. i. p. 207.

Fig. 3. from the cabinet, is one of the lower teeth, also very little worn. It was found in the neighbourhood of Avignonet.

Fig. 4. is the germ of an upper molar tooth nearly similar to those of fig. 2.: it is in the museum, but it is not known in what place it was found.

Fig. 5. a posterior upper molar tooth of the right side, not much worn, from the environs of Canstadt. It was sent to me by M. Autenrieth, professor at Tubingen.

Fig. 6. is the germ of a posterior upper molar tooth of the left side, from the living two-horned rhinoceros.

Fig. 7. an anterior upper molar tooth of a large individual in the collection of the museum: the origin of it is unknown.

Fig. 8. is an inferior molar from the environs of Canstadt. It was also sent to me by M. Autenrieth.

I shall return to these different teeth in another memoir.

3d, *Of the Vertebræ.*

Of these there are 56 in all.

7 Cervical.
19 Dorsal.
3 Lumbar.
5 Sacral.
22 Coccygian.

The *atlas* has its transverse apophyses as large and broad as that of any other animal. They have a hole instead of the indentation at the base of their anterior edge. The spinal is only a large tubercle. Under the body there is a small longitudinal ridge.

The transverse apophyses of the axis are small, and turned backwards: those of the following ones are very broad, and descend towards the ribs: they have three angles, an anterior and two posterior.

The seventh has only a small one which touches the sixth, and which must considerably confine their respective movement.

The spinal apophyses go on increasing: that of the third vertebra is only 0·04, that of the seventh 0·25.

That of the second dorsal is longer, it is 0·40; it is besides very thick: they then go on decreasing in length, and becoming flat on the sides to the thirteenth, which is the lowest, it is 0·12, and they then again increase. The first lumbar is 0·15; the three spinal apophyses of the lumbar are vertical; all those of the back are turned backwards; the transverse apophyses are very short, and present to the

tubercles

tubercles of the ribs facets almost vertical; those of the loins are a little longer.

The five spinal apophyses of the os sacrum coalesce into one ridge. The first six vertebræ of the tail have an annular part, and spinal and transverse apophyses; the other sixteen are merely pyramidal, and go on decreasing in size*.

4th, The Ribs.

There are nineteen pairs, several of which are real; those of the first pair are united together at the bottom. The sternum is composed of four bones; the first is compressed into the form of a plough-share, and makes a pointed projection before the first rib.

5th, The Anterior Extremity.

The omoplate is oblong; its greatest breadth is at its upper quarter; its posterior edge is raised up, and in that place thickened. The ridge has a very prominent apophysis, at the upper third turned a little backwards; it terminates at the lower quarter of the omoplate, consequently there is no acromion: a tuberosity supplies the place of the coracoid beak; the glenoid cavity is almost round.

This form of the omoplate of the rhinoceros will always distinguish it from those of other large quadrupeds;—that of the elephant, for example, is a triangle almost equilateral, and the spine has a large recurrent apophysis.

The humerus is very remarkable, as its thick tuberosity is a broad ridge, which proceeds from before backwards, and as the linea aspera, which is thereby triangular, instead of being linear, terminates at the bottom by a very prominent hook. The anterior extremity of the thick tuberosity forms a hook forwards; the small produces a simeral one, and between both is a large canal, destined, no doubt, for the passage of the biceps tendon. All these characters will still form a very good distinction between the humerus of the rhinoceros and that of every other quadruped of its size. The exterior condyle is not very prominent; the other is not prominent at all; the lower articulation is a simple pulley half hollow.

The radius at the top occupies the whole fore part of the fore arm; its head has the form of a simple prominent

* Length from the extremity of the upper jaw to the root of the tail - - -	2·9
Length from the cervical part of the spine -	0·5
Length from the dorsal part - -	0·3
Length from the lumbar part - -	0·2
Length from the sacral part - -	0·2
Length from the coccygian - -	0·7

pulley; it can bend but not turn: at the bottom it becomes nearly as broad as at the top, and terminates in two short apophyses; one anterior, which is pointed, and one truncated; the latter receives the semilunar; between them is a fossa, which receives the scaphoid; its greatest contraction is towards its upper third.

The cubitus, almost every where triangular, has towards the bottom a cavity which receives a projection of the radius; it is terminated by a cavity for the cuneiform bone; the olecranon is very much compressed, swelled at the end, and forms the fourth of the whole bone*. The carpus is composed of eight bones; the scaphoid and unciform are very large; the pisiform is almost round.

On the scaphoid and trapezoid is a bone out of rank, which is analogous to the trapezoid, and the only vestige of the thumb: the semilunar, the great bone, which here is one of the smallest, and the unciform have large protuberances on the palmar face†.

The exterior metacarpian is articulated with the unciform, and has on its interior side two facets for the mean; the latter is articulated with the great bone by a very concave facet, and with the unciform by a small one. The interior is articulated with the trapezoid and the great bone, and touches the middle one by a small triangular facet.

6th, *Posterior Extremity.*

The pelvis is exceedingly broad; the wide part of the bones of the ilium being 0·5 in breadth: its spine is forked, which distinguishes it from the whole series of the bones of the ilium in the elephant: the angle which touches the sacrum is also more elevated; the neck in particular is much

* Length of the omoplata - -	0·53
Breadth at its superior third - -	0·23
Breadth at the neck - - -	0 09
Height of the tuberosity of the spine -	0·15
Length of the humerus - -	0 44
Breadth at the top - - -	0·2
Breadth at the bottom - -	0·17
Diameter of the body - -	0·08
Length of the radius - -	0·38
Breadth at the top - -	0·12
Breadth at the bottom - -	0·12
Length of the cubitus - -	0·5
Length of the olecranon - -	0·13
Height of the olecranon - -	0·1
Diameter of the body of the cubitus -	0·05
Diameter of its inferior head -	0·08
† Length of the carpus - - -	0·109
Length of the middle metacarpian -	0·018
Length of the middle finger -	0 012

much longer and narrower; it is 0·15 in length and 0·08 in breadth; the exterior edge of this bone is nearly as great as the interior, while in the elephant it is much smaller; the ridge of the pubis begins at the upper part of the neck of the bones of the ilium; the oval foramina are broader than they are long; the tuberosity of the ischion is at the top very thick and in the form of a hook.

The femur of the rhinoceros is perhaps still more remarkable than its humerus; its upper part is very much flattened from before backwards; the eminence, which I call the third trochanter, projects very much, and forms a hook which ascends to touch a hook which descends from the common great trochanter, in such a manner that there remains an oval hole between these two eminences; the lower pulley is very narrow before; the interior condyle is much more prominent, and ascends higher than the other behind; the two condyles are at a greater distance than they are before, but they make nearly the same projection. The head of the tibia is an equilateral triangle, only the interior posterior angle forms a very strong tuberosity below the rotula. The lower part of the tibia is a little flattened from behind backwards; the perone is slender, compressed laterally, and swelled at its two extremities*. The calcaneum is thick and short; its anterior or astragalian face is triangular. There are two large facets for the astragalus; that of the interior sides is lengthened into a kind of tail along the lower edge of that face. In my opinion this is a character proper to distinguish the species. The facet which touches the cuboid is very small; the facets of the astragalus are a counterpart of those of the calcaneum; the two edges of its pulley are of equal height; the part of the anterior face, which touches the cuboid, is narrow.

The cuboid has behind a long and thick protuberance; on the interior side of the foot there is a similar production by a supernumerary bone attached to the scaphoid, to the interior cuneiform, and the interior metatarsian; the scaphoid then has three articular facets on its anterior face; the interior cuneiform is much smaller than the other.

* Length of the femur	-	0·5
Its breadth at the top	-	0·2
Breadth at the bottom	-	0·15
Length of the tibia	-	0·4
Its breadth at the top	-	0·14
Breadth at the bottom	-	0·11
Diameter of the body	-	0·09
Length of the perone	-	0·34
Breadth at the bottom	-	0·05

 The

The exterior metatarsian articulates only with the cuboid, and touches by two facets of the exterior edge of its head the middle metatarsian; the latter is articulated only with the great cuneiform, and by the exterior to the supernumerary bone, for which it has only one facet.

The phalangia are broader than long*.

XIX. *Observations on the Electricity of Metallic Substances. By M.* Hauy†.

The different methods of exciting in bodies the electric virtue, furnish characters from which great advantage might be derived in regard to the distinction of minerals; the most remarkable is that which results from the electricity produced by heat, and which hitherto has been observed only in six species of minerals, viz. tourmalin, borated magnesia, topaze, mesotype, phrenite, and oxidated zinc. Another method of exciting the electric virtue consists in friction, to which idio-electric substances are subjected. This virtue, as is well known, is of two kinds; one which we call *vitreous electricity*, and which belongs in general to earthy and acidiferous substances, and another distinguished by the name of *resinous electricity*, and which characterizes more particularly non-metallic combustible substances, the diamond excepted, the electricity of which is vitreous. Other substances are non-electric, and, to acquire the electric virtue, have need of being brought into communication with a conductor already endowed with that virtue. Metals in the metallic state possess, in an eminent degree, the faculty of becoming electric in this manner, which may be employed to detect a metal concealed in a stony substance. This is the case with iron, which enters into the composition of jasper, and the presence of which is announced by the sparks emitted by the stone on the finger being applied to it, while it is in contact with an electrified conductor.

I conceived the idea of employing in another manner the electricity of metallic substances, by insulating them, and rubbing them over an idio-electric substance. The latter then acquires an electricity, the kind of which varies according to the nature of the metal used as a rubber; and by

Length of the calcaneum at its exterior edge	-	0·13
Breadth of its articular face	-	0·09
Breadth of the astragalus	-	0·08
Length of the middle bone of the metatarsus	-	0·165
Length of the middle finger	-	0·11

† From *Annales du Museum National d'Histoire Naturelle*, No. 17.

a necessary

a necessary consequence, the metal acquires the contrary kind of electricity, and retains it at least for a moment, because it is insulated: for example, if tin be employed to rub a silk ribband, it produces in it vitreous electricity, instead of the resinous electricity which would be excited by friction with the hand; and, on the contrary, the tin is electrified in the resinous manner. Having then observed that the different metals tried, acquired in this manner some vitreous, and others resinous electricity, I thought that this diversity of states might increase the number of distinguishing characters which mineralogy borrows from natural philosophy.

To make experiments on this subject, I insulate the agment of metal I intend to try, affixing it by common wax to the extremity of a stick of gum-lack, or Spanish wax; then holding the stick in my hand, I make the metallic fragment pass several times over a piece of cloth. If the surface of the fragment be rough, it will be necessary to smooth it by means of a file: after rubbing it five or six times, I make the metallic fragment touch the knob of the collector, a well-known instrument, invented by Volta, to serve at the same time in electric and galvanic experiments, as a condenser and electrometer. Having repeated this operation several times, and removed the disk which performs the office of condenser, I determine in the usual manner the kind of electricity which produces the separation of the two straws of the electrometer.

I shall now present a table of the different metals which I subjected to experiment, with an indication of the result given by each. I comprehend in this list metals which have not yet been found naturally in the metallic state, and which are not obtained in that state but by separating them from the principles by which they are mineralized. I took care to note the substances in which friction excites the electric virtue with more facility and in a more energetic manner than in others:

Metals which acquire vitreous Electricity.

Zinc, strong.
Silver.
Bismuth, strong.
Copper.
Lead.
Oligist iron.

Metals

Metals which acquire resinous Electricity.

Platina.
Gold.
Tin.
Antimony.
Gray Copper, strong.
Sulphurated copper, strong.
Pyritous copper, strong.
Sulphurated lead.
Tellurium of Nagyag, strong.
Antimonial silver.
Sulphurated silver, strong.
Nickel.
Gray cobalt.
Arsenical cobalt.
Sulphurated antimony.
Sulphurated iron.
Oxydulous iron.

In proofs in regard to silver, copper, and other metals, found in a native state, I operated on fragments which were in that state, and on others arising from the fusion of these metals.

I repeated my experiments a great number of times, and almost always obtained the same results; oxydulous iron and oligist iron alone exhibited anomalies by acquiring, under certain circumstances, an electricity different from that indicated in the table.

Steel, which in general acquires vitreous electricity, gave also some exceptions, arising in all probability from a difference in the quantity of carbon united to the iron, or perhaps in the effect of the temper. Those habituated to electric experiments know that the faculty of acquiring one kind of electricity rather than another, by the help of friction, differs sometimes by such slight shades that they escape the most attentive observer.

If the two parts of the above table be compared, it will be observed that metallic substances, which have the same aspect, differ from each other in the results of electrisation. From these results one will be able to avoid confounding silver with platina; the same kind of silver with antimonial silver, native copper with pyritous copper, oligist iron with gray copper, &c., all the first substances giving signs of vitreous electricity when they have been rubbed, while all the second manifest the contrary electricity.

There

There are some metallic substances also, which, in the same case, acquire an electricity so sensible, that the energy of its effects alone may serve to confirm the indications offered by the other characters. Such are sulphurated copper, which have no need of being passed eight or ten times over cloth to make the first contact with the collector often produce repulsion between the straws of the electrometer, in virtue of which the straws touch the sides of the glass flask in which they are suspended.

To conclude; the metals have other properties which distinguish them so clearly from each other, that the characters deduced from the preceding experiments will appear superfluous; but I thought it would not be a matter of indifference to collect and make known the results of these experiments, considering them only as simple facts, connected with a branch of natural philosophy, which for some years has been doubly interesting by the beautiful discoveries to which metallic substances themselves have given birth.

XX. *Observations on Tea.* *By* Desfontaines *.

Hill, Linnæus, and others, have thought it necessary to distinguish two kinds of tea; namely, bohea tea, *thea bohea;* and green tea, *thea viridis;* because, according to these writers, the one has six petals, and the other nine. Linnæus adds, that the leaves of the former are longer than those of the latter. Such are the only characters which establish the difference between them: but, according to the observations of Dr. Lettsom, published in 1799, the number of the petals of the green tea and the bohea tree are subject to vary from three to nine, so that the principal character indicated by Hill and Linnæus is not admissible: and as Lettsom could find no other, he considers, and with justice, green tea and bohea tea to be two varieties arising from the influence of climate and soil. Thunberg, in his *Flora Japonica,* admits only one species, and he is of opinion that the green tea is a variety of the bohea. Kempfer also acknowledges only one species, which, like all cultivated plants, has produced several varieties. In a word, the observations which I made on some individuals cultivated in the garden of the Museum of Natural History, two of which produced abundance of flowers last year, have

* From *Annales du Museum National d'Histoire Naturelle,* No. 19.

served

served to convince me of the exactness of those of Kempfer, Thunberg, and Lettsom.

Tea is a branchy evergreen shrub, which, according to Kempfer and Thunberg, grows to the height of five or six feet, though other travellers assert that it rises sometimes to thirty.

Its leaves are alternate, hard, oval, and elongated, or elliptic; of a somewhat shining green colour, entire near the base, but serrated in the rest of their length, and supported on a short and half-cylindric foot-stalk. The buttons are acute, and accompanied with a husk, which detaches itself and drops off at the period of their development.

The flowers grow singly, or sometimes, but more rarely, two-and-two, in the eyes of the leaves, on short and somewhat thick pedicles.

The calyx is small, persistent, and has five obtuse divisions.

The corolla, for the most part, has six white petals, round and open: the two exterior ones are smaller and unequal. Its breadth is about three centimetres.

The stamina, which are more than two hundred in number, are shorter than the corolla, and attached under the ovarium. Each anthera has two cells.

The ovarium, which is of a rounded triangular form, and surmounted by a style divided into three filiform stigmata, becomes a capsule with three round monospermous cells united at the base, and opening longitudinally on one side only.

The seeds are spherical, internally angular, of the size of a filberd, covered with a thin shining pellicle, a little hard, and of a maroon colour. The kernel is oily, and of a bitter and disagreeable taste, which produces salivation, and even occasions nausea.

The tea often flowers in Europe, but it rarely fructifies. It belongs to the order and class of the *Polyandria monogynia* Linn.; and M. de Jussieu has classed it in the family of the orange trees next to the *camelia*.

It is cultivated every where, from Canton to Pekin; where the winter, according to the observations of the missionaries, is more severe than at Paris. It would, no doubt, be possible to propagate this valuable plant in France, if one could procure a sufficient number of individuals to make experiments, by cultivating it in different soils and under different climates. This object deserves the attention of government, as the consumption of tea is immense, and as the quantity imported every year amounts to a considerable sum,

sum, for which Europe is rendered tributary to China. The tea seeds brought to us from that country become rancid, and spoil at sea; so that scarcely one of a thousand produces plants. It would, therefore, be necessary that persons who go to China should procure them exceedingly fresh, and take care to sow them, before they sail, in boxes filled with light earth: they would then spring up on the passage. Nothing would be necessary but to water them from time to time, and to preserve them from the sea water: the young plants might then arrive in safety. We are assured that the Chinese often sell to the Europeans the seeds of the *camelia* for those of tea, to which they have a great resemblance: this deception ought to be guarded against, and might easily be prevented.

What I have to say on the culture, preparation, and uses of tea, is collected from Kempfer, and other travellers worthy of credit; and though I have little to add to what they have said, I hope this extract will still be useful, because it will exhibit in one point of view several scattered and little known facts.

In Japan the tea is sown in the month of February, at certain distances, on the borders of the cultivated fields, that its shade may not injure the crops, and that the leaves may more easily be collected; and as the seeds are liable soon to spoil, from six to twelve are sown in the same hole, because no more than about a fifth of them spring up. In China it is cultivated in the open fields. It thrives exceedingly well on the declivities of the hills exposed to the south, and in the vicinity of rivers and streams. When the young plants have attained to the age of three years, the leaves may be collected from them. At the age of seven they produce only a small quantity; the trunk is then cut near to the root, because the stock sends out new twigs which yield abundant crops: sometimes this operation is deferred till the tenth year.

The leaves of the tea are detached one by one: the best are those gathered at the end of February, or in the beginning of March, when the leaves are still tender and not completely expanded. This tea is scarce, sold at a dear rate, and reserved for the rich and persons of rank. The Japanese call it imperial tea, flower of the tea, or *bon* tea: it is that most esteemed. The second crop is collected a month later: the leaves, whether expanded or not, are gathered without distinction; after which they are separated into several heaps, according to their different degrees of age. After this second crop, a third and last are collected: the last

last is the most abundant; but it gives tea of less value, which is consumed by the common people.

The tea of the first quality, or *bon* tea, which the Japanese call also *fieki-tsjaa*, is pounded and reduced to a fine powder, which is infused in boiling water. The quality of it varies according to the soil, the climate, and the age of the shrubs which have produced it.

Tea of the second crop, called Chinese tea, and also *too-tsjaa*, is generally distinguished into four classes, in regard to the different degrees of goodness.

That of the third, which they call *ban-tsjaa*, composed of older and harder leaves, and prepared with less care, has also its different degrees of value. When the tea-harvest is ended, it is celebrated by public festivals and amusements.

The most esteemed tea of Japan, according to Kempfer, grows in the environs of the small town of Udsi, situated in the neighbourhood of the sea: in that district is a celebrated mountain, which is entirely employed for the cultivation of that used by the emperor. This mountain, which has a beautiful and picturesque appearance, is surrounded by a broad ditch, to prevent men and animals from having any access to it. The plantations are laid out by the line, arranged in a manner exceedingly agreeable to the eye, and the shrubs are washed and cleaned every day. While the leaves are collecting, the men employed in that operation bathe two or three times every day, and wear gloves when they pick the leaves, to prevent them from being dirtied. When the leaves have been torrified and properly prepared, they are shut up in vessels of great value, and conveyed with much pomp to the emperor's palace.

Tea is prepared in public edifices, which are provided with the necessary apparatus. Some pounds of the leaves, fresh gathered, are put into a kind of pan, made of thin iron plate, broad but not deep, of a circular or square form, and heated by means of a stove destined for that purpose, and of which a description may be seen in Kempfer. They are stirred and rapidly turned with the hands, that they may be torrified in as uniform a manner as possible; and the operation is continued until they emit a sort of crackling noise on the plate. The heat, by depriving them of their juices, destroys that intoxicating and noxious quality which they naturally possess. They must be torrified when exceedingly fresh, because if kept some days they would become black and lose their value. The heat of the pan ought to be so great as scarcely to admit of its being touched with the hand. In China the leaves are immersed in boiling water for half a minute

minute before they are roasted. When properly torrified, they are taken from the pan with a wooden spatula, and distributed to persons specially charged with the care of rolling them. This operation is performed by rolling them rapidly, and with an uniform motion, with the palm of the hand, on tables a little raised, and covered with very fine mats made of straw. The slight compression which they then experience expresses from them a greenish yellow juice, which produces on the hands a heat almost insupportable; yet the operation must be continued till they are cold, for they can be rolled only while hot; and, that they may not unroll themselves, it is essentially necessary that they should cool under the hand: the more rapid the cooling, the better they continue rolled. It is even accelerated by agitating the air with a sort of fan: but, whatever care may be taken, there are always a certain number which become unrolled. The rolling is still continued; and those which, for want of having been sufficiently dried, are not susceptible of rolling, are torrified a second time, care being taken to check the action of the fire, to prevent their being blackened or burnt. Some torrify and roast the leaves five or six times, gradually diminishing the intensity of the heat: by this practice they retain better their green colour, and are less liable to become altered. Each time the operation is begun, the pan is washed with warm water, to remove the juices and other heterogeneous parts which may adhere to it. The leaves, thus prepared, are spread out on mats; and those which are thick, badly rolled, or too much burnt, are separated. Leaves of the first quality ought to be more torrified than the rest, in order that they may be more readily pulverised. When gathered young, and exceedingly tender, they are merely immersed in warm water; then dried, by means of a charcoal heat, on pieces of pasteboard; and, on account of their small size, are not rolled.

The inhabitants of the country torrify their tea without much precaution, stirring it in earthen vessels exposed to heat. This tea is often of a good quality, though sold at a low price; and M. Cassigni asserts that in Cochin-china it is not customary to roll the leaves.

At the end of some months, the tea is taken from the vessels in which it is contained, and again exposed to a gentle heat, to deprive it of all its moisture, and that it may run no risque of becoming worse.

To preserve tea, it must be put into close vessels, and completely defended from contact with the air. Kempfer asserts that the tea brought to Europe has always lost some part

part of its quality, and that he never found in it that agreeable taste and delicate flavour which it has in the country where it grows. The Japanese keep it in vessels made of tin, and, when large, they are put into boxes of fir to support them and give them more strength, and the joints of the boxes are closed both inside and outside with paper. That destined for the emperor and grandees is put into valuable vessels of porcelain, or of some other substance. It keeps them exceedingly well, and, as is asserted, even improves. The third sort of tea is that least susceptible of alteration. The peasants preserve it in vessels made of straw, which they suspend from the roofs of their houses. The author of Lord Macartney's Voyage says, that in China the tea is heaped up, and trod with the feet in large boxes of wood lined with sheets of lead.

Tea is perfumed with the flowers of a kind of mugwort, those of the scented olive, the *camelia usanqua*, the Arabian jasmin, the curcuma, or Indian saffron, &c.

Some authors have advanced that tea is torrified on plates of copper, and that its colour arises particularly from verdigris; but Kempfer says, positively, that it is torrified on plates of iron. The writer of Lord Macartney's Voyage asserts the same thing; and Dr. Lettsom was never able to discover a particle of copper, notwithstanding the number of trials he made with a great number of kinds of tea; so that this imputation is void of foundation.

Some drink tea in infusion: others pulverise it in small mills made of stone, turned by means of the hand. It is ground on the evening before it is to be used. This custom is common among the rich. Boiling water is poured into the cups, and a certain quantity of pulverised tea, taken up with a spoon, is thrown into them: it is then mixed with a wooden instrument, like a chocolate-stick, which is moved in a circular direction with the hand.

The third manner of taking tea is in decoction, which is used only among the country people. They boil water in a pot, then throw in a few handfuls, more or less according to the company, of tea-leaves of the third quality, and drink it prepared in this manner to quench their thirst. Sometimes they boil the tea-leaves in a bag, in order that they may not become mixed with the water. That which has lost its virtue is employed in dyeing silk, to which they communicate a brown colour.

Fresh tea has an intoxicating quality, which attacks and irritates the nerves, and which it does not entirely lose by torrifaction: it is even asserted that it is not completely freed

freed from it before the end of ten or twelve months; it is then pleasant and wholesome, and excites cheerfulness. The Japanese never drink it fresh, without mixing with it an equal quantity of old tea. It removes obstructions, assists digestion by rousing the action of the stomach; and there is no plant known of which people can drink an infusion so frequently, and in such large quantity, without disgust. The Chinese consider it as exceedingly salubrious. They never mix with it milk, syrup, or strong liquors. They drink it pure, with a little sugar-candy which they hold in their mouth; and the habitual use which these people have made of it for so many centuries, proves that when well prepared it has no prejudicial qualities. They form from it also an extract, which they use diluted in a large quantity of water, and to which they ascribe great virtues in various maladies. Kalm asserts that tea is of great service in correcting the bad quality of water, that it revives the strength, and that it was of much benefit to him during his travels.

In commerce, tea is distinguished into eight principal kinds; three of which are green tea, and five bohea: but I shall here observe that the bohea tea of the shops is not the same as that known under this name by the Chinese. The three kinds of green tea are: 1st, *Imperial tea*, or the *flowers of tea*. Its leaves are not rolled: they are of a bright green colour, and have an agreeable odour. 2d, *Haisven*, or *hysson*, which takes its name from an Indian merchant who first brought it to Europe. The leaves are small, and strongly rolled; they have a green colour inclining to blue. 3d, *Singlo*, or *songlo tea*, which, like several other kinds, is called after the name of the place where it is cultivated.

The five sorts of bohea tea commonly known in commerce are: 1st, *Suchong*; the leaves of which are broad, not rolled, and of a colour inclining to yellow. It is imported into Russia by the caravans in packets of half a pound. 2d, *Sumlo* tea, which smells like violets, and the infusion of which is pale. 3d, *Congo*; the leaves of which are broad, and the infusion high-coloured. 4th, *Peko* tea, which is known by the small white leaves mixed with it. 5th, *Bohea*; the leaves of which are of a brownish green and uniform colour: a kind of tea rolled up in balls of different sizes, the leaves of which are united by a glutinous substance which does not alter their quality, is also brought from China. There are likewise balls of medicinal tea, composed of leaves impregnated with a decoction of rhubarb; and there are several other varieties which it is needless to mention.

Tea was first introduced into Europe by the Dutch. In

1641, Tulpius, a celebrated physician, and consul at Amsterdam, wrote in praise of its good qualities. It is asserted that he did so by desire of the Dutch East-India company, who rewarded him with a considerable sum of money. In 1667, Jonquet, a French physician, extolled its virtues. In 1678, Bontetre, physician to the elector of Brandenburgh, who had acquired great reputation, bestowed high encomiums on its qualities, in a dissertation which he published on tea, coffee, and chocolate. This work was attended with great success, and contributed not a little to render the use of it more general; and, before the end of the century, the consumption of it was considerable. According to a table published in Dr. Lettsom's work, the quantity of tea imported into Europe from China, between the years 1776 and 1794, amounted annually to fifteen, twenty, twenty-five, twenty-nine, and even thirty-six millions of pounds; an enormous consumption, for which Europe pays every year a large sum which it no doubt might save.

The use of tea in China may be traced back to the earliest ages; and it is so prevalent among all classes in this immense empire, that, according to the author of Lord Macartney's Voyage, if the Europeans should give up the tea trade, the value of it in the country would not be much lessened.

The Japanese ascribe to tea a miraculous origin. Darma, a very religious prince, and third son of an Indian king, named Kosjusvo, landed in China, they say, in the year 510 of the Christian æra. He employed all his care to diffuse throughout the country a knowledge of the true God and religion; and, being desirous to excite men by his example, imposed on himself privations and mortifications of every kind; living in the open air, and devoting the days and nights to prayer and contemplation. After several years, however, being worn out with fatigue, he fell asleep against his will; and that he might faithfully observe his oath which he thought he had violated, he cut off his eye-lids and threw them on the ground. Next day, having returned to the same spot, he found them changed into a shrub which the earth had never before produced. Having eaten some of the leaves of it, he found his spirits exhilarated, and his former vigour restored. He recommended this aliment to his disciples and followers. The reputation of tea increased, and after that time it continued to be generally used. Kempfer, in his *Amœnitates exoticæ*, gives the life with a portrait of this saint so celebrated in China and Japan. There is seen, at the feet of Darma, a reed, which indicates that he had traversed the seas and rivers.

XXI. *On a Liquid Sulphur. By Professor* LAMPADIUS*.

In the year 1796 I discovered a liquid sulphur, which I obtained while distilling martial pyrites with charcoal, in order to try whether I could not extract a greater quantity of sulphur from that mineral. I then sent a small quantity of this liquid to my late friend Gren, accompanied with a short notice in regard to some of its principal properties. Chemists, since that time, have paid little attention to this subject; and though I have frequently repeated the experiment, I was never able to find this substance again. I was obliged to suspend these researches, but without entirely abandoning the subject.

Performing some operations lately on pyritised wood, I succeeded in finding different methods of preparing this remarkable substance, and have even examined several of its properties; I shall, therefore, here give an account of my new observations, reserving the more ample details for another opportunity.

I obtained this liquid, which for the present I shall call alcohol of sulphur, by the distillation of pyritised wood alone, or by distilling martial pyrites with common or bituminous wood, fossil wood, coals, or anthracite. The manner of preparing it is as follows:—Charge an earthen retort with a proper quantity of the earth, and to the beak join an adaptor, which is immersed in a receiver filled with water: a communication, by means of a tube, is formed between the latter, with a pneumato-chemical apparatus. When the whole is well luted, kindle the fire, carry it to a white heat, and conduct the operation nearly in the same manner as for the preparation of phosphorus. A large quantity of sulphurated hydrogen gas is at first disengaged, except when anthracite is employed, and a little empyreumatic oil; but, as soon as the retort is very red, the alcohol of sulphur passes in small liquid drops, which fall to the bottom of the water: when anthracite is employed it is white, and contains no empyreumatic oil, with which it is always tainted when the other substances are used. To separate this oil, it is again distilled by a lamp heat in a retort with a little water, and the beak of the retort is immersed in distilled water. By this means it is obtained perfectly white.

The proportions of the substances which I put into the retort, and which no doubt might be varied, were:

* From the *Annales de Chimie*, No. 147.

1 pound of pyritised wood, coarsely pulverised, (gave two ounces of alcohol of sulphur);
4 ounces of pyrites, and 1 ounce of bituminous wood;
4 - - - and 1 ounce of fossil wood;
4 - - - and 1 ounce of coals;
4 - - - and 1 ounce of saw-dust;
4 - - - and 1 ounce of anthracite.

These substances, reduced to powder and treated as above, gave from 7 to 8 gros of alcohol of sulphur.

Since anthracite gives no empyreumatic oil, but only carbonated hydrogen gas (perhaps also gaseous oxide of carbon), it appears that the presence of this oil is not necessary to the formation of the product, which can be considered only as a compound of empyreumatic oil and sulphur.

In all these operations, less sulphur is obtained than in distilling martial pyrites alone. There may be other means of preparing this substance, but I never obtained any of it when I employed charcoal with pyrites. It is possible that that which I took in 1796 was not completely carbonised, as sometimes happens, or that some circumstance in the operation had particularly favoured the combination of the sulphur with the substance which constitutes the alcohol of sulphur.

Of the numerous properties of this substance, I remarked only the following:

1. A penetrating odour.

2. Extreme volatility. Alcohol of sulphur boils at 32° of Reaumur; the barometer being at 26 in. 6 lines. By evaporation it produces a great deal of cold; and in this respect it surpasses all the others known.

3. The specific gravity is 1300, which is the more extraordinary considering its volatility.

4. It is exceedingly inflammable: the least electric or galvanic spark is sufficient to make it burn, and it leaves no residuum by its combustion. The product, on the contrary, is sulphuric acid and a little water. Hitherto no carbon has been found. The flame is blue, and without smoke.

5. It is exceedingly soluble in spirit of wine.

6. It dissolves phosphorus with extreme rapidity, and without the aid of heat. If a little of this solution be put on paper, the paper inflames at the end of ten or fifteen minutes. This solution when poured into water does not shine. At 10° of Reaumur the alcohol of sulphur can dissolve a weight of phosphorus equal to its own.

7. It has an extraordinary refringent power.

8. Water dissolves only a very small quantity of it, and it then assumes all the properties of sulphurated water.

I mention these properties only until I can make further researches: they are sufficient to enable one to distinguish the substance; the constituent parts cannot be exactly determined, but by repeating and varying the experiments.

Sulphur more than the half of its weight, as appears from properties 4 and 8, and hydrogen, are no doubt the principal elements of alcohol of sulphur. If I thought that no carbon were to be sought for in this substance, I should have given it the name of hydrogenated sulphur: until its nature be more precisely determined, that of alcohol of sulphur is applicable to it on account of its volatility.

hope that this substance will be found hereafter a powerful remedy in cases in which ether is employed.

Freyburg, Jan. 28, 1804.

P. S. Should this substance be found to be the same as that of Clement and Desormes, I must claim the priority of my discovery, which was made in 1796. But this is of little importance, except that a fact when observed by several persons who have not communicated to each other their observations may be considered as the more authentic.

Note—Since writing the above, I have read the experiments of Clement and Desormes with great attention, in Gilbert's Annals, and am surprised at the resemblance which exists between the two products. I, however, find the following differences:

Clement and Desormes' *Carburated Sulphur.*	*Alcohol of Sulphur.*
1. Burns, and leaves a residuum of carbon.	1. Burns, and leaves no residunm.
2. Deposits carbon in combining with fat oils.	2. Dissolves entirely in fat oils.
3. With spirit of wine it is converted into a soft mass, and a small portion is dissolved.	3. Dissolves entirely in spirit of wine.
4. It is now obtained from sulphurated iron.	4. See the preceding experiments.

I am engaged in experiments to answer the following queries:

Is my product hydrogenated sulphur? or sulphurated carbon? or carbon, sulphur and hydrogen? or perhaps the base of sulphur?

Feb. 2, 1804.

XXII. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones.* By David Mushet, Esq. of the Calder Iron-Works.

[Continued from p. 36.]

With a view to obtain results from ores compounded similar to those which we use at furnaces in the scale of manufacture, the four following classes were carefully made and operated upon:

4th Class consisted of

40	parts	of oxide,
20	——	of chalk,
20	——	of sand,
20	——	of clay.
100		

5th Class.

40	parts	of oxide,
30	——	of chalk,
30	——	of clay.
100		

6th Class.

40	parts	of oxide,
30	——	of sand,
30	——	of clay.
100		

7th Class.

40	parts	of oxide,
30	——	of sand,
30	——	of lime.
100		

As the details of these experiments might be deemed tedious, I shall confine myself merely to tables of the results obtained from each compound respectively; by which it will be easily perceived that the peculiar properties of the respective earths still exist where they are not corrected by an equality of mixture, or where lime is not used as one of the principal ingredients.

Results

Results of 4th class, compounded of

40 parts of oxide,
20 —— of chalk,
20 —— of clay,
and 20 —— of sand.

Quantity of matter used in each experiment 400 grains.

						per cent.
Exp. I.	1-30th	of carbon yielded	2½	grs. of iron,	or	625
II.	1-20th	ditto ——	35	ditto,	or	8·75
III.	1-15th	ditto ——	58	ditto,	or	14½
IV.	1-10th	ditto ——	95	ditto,	or	23¾
V.	1-7th	ditto ——	111	ditto,	or	27¾

This last experiment was a perfect assay. The glass was of a dull flinty colour, considerably transparent, and proves that under similar circumstances an ore equally composed of clay, lime, and silex, will smelt to greater advantage than one either exclusively united to silex or clay.

Results of 5th class, compounded of

40 parts of oxide,
30 —— of chalk,
30 —— of clay,

Quantity of matter operated upon 400 grains.

						per cent.
Exp. I.	1-30th	of carbon yielded	7	grs. of iron,	or	1¾
II.	1-20th	ditto ——	38	ditto,	or	9½
III.	1-15th	ditto ——	51	ditto,	or	12¾
IV.	1-10th	ditto ——	78	ditto,	or	19½
V.	1-7th	ditto unfused.				

Results of 6th class, compounded of

40 parts of oxide,
30 —— of clay,
30 —— of sand.

Quantity of matter operated upon 400 grains.

						per cent.
Exp. I.	1-30th	of carbon yielded	16	grs. of iron,	or	4
II.	1-20th	ditto ——	30	ditto,	or	7½
III.	1-15th	ditto ——	57	ditto,	or	14¼
IV.	1-10th	ditto unfused.				

Results of 7th class, compounded of

40 parts of oxide,
30 —— of sand,
30 —— of chalk,

Quantity of matter in each experiment 400 grains.

						per cent.
Exp. I.	1-30th	of carbon yielded	1	gr. of iron,	or	¼
II.	1-20th	ditto ——	13	ditto,	or	3¼
III.	1-15th	ditto ——	40	ditto,	or	10
IV.	1-10th	ditto ——	103	ditto,	or	25¾
V.	1-7th	ditto ——	129	ditto,	or	32¼
VI.	1-5th	ditto unfused from an excess of carbon.				

If the results of this class are compared with those of Class 5, it will be found that an ore compounded of sand and lime is more easily fused, and ultimately more productive, than one equally composed of clay and calcareous earths.

In these classes I deemed it of some importance to add an eighth. It has of late been received and believed by the most of Europe, that the French chemists have discovered a process of imparting carbonaceous matter to iron by the decomposition of the carbonic acid, and that in such quantity as to convert soft iron into cast steel. Those who rest in the belief of this discovery must naturally have expected that in these experiments the greatest quantity of iron would have been revived where the carbonate of lime was used, and that this quantity would have borne an exact relation to the proportions of the carbonate.

The very reverse of this, however, turns out to be the fact; for it requires double and sometimes triple the quantity of carbonaceous matter to be added to revive the same quantity of iron when carbonate is used, than is requisite with either clay or silex.

To ascertain what difference would arise betwixt the result of the experiments with chalk, and the same deprived of its acid, the following experiments were made:

Results of 8th Class, compounded of

40 parts of oxide,
60 —— of chalk deprived of its acid.

Quantity of matter (deeming it more unfusible) made use of, 200 grains.

Exp. I.	1-30th of carbon yielded no metal.					
II.	1-20th	ditto	—		ditto	
III.	1-15th	ditto	—		ditto	
IV.	1-10th	ditto	—	6 grs. of iron,	or	3 per cent.
V.	1-8th	ditto	—	37	ditto	$18\frac{1}{2}$
VI.	1-7th	ditto	—	53	ditto	$26\frac{1}{2}$
VII.	1-5th	ditto	not fused.			

If these results are compared with those of Class 1, it will be evident that a larger proportion of charcoal is requisite in the present case to revive the first portions of iron; but then it ought to be considered that the oxide is presented with a larger proportion of calcareous earth by all the quantity of acid and water of crystallization contained in the carbonate.

General

General Table of the Results of the Eight Classes of compounded Ores.

Proportions of Carbon.	1st Class. Oxide 40 Clay 60	2d Class. Oxide 40 Sand 60	3d Class. Oxide 40 Lime 60	4th Class. Oxide 40 Lime 20 Clay 20 Sand 20	5th Class. Oxide 40 Lime 30 Clay 30	6th Class. Oxide 40 Clay 30 Sand 30	7th Class. Oxide 40 Sand 30 Lime 30	8th Class. Oxide - 40 Deacidified Lime } 60
1-40th	$2\frac{8}{10}$ per ct.	$1\frac{4}{10}$ per ct.	no iron	no iron	no iron	no iron	no iron	no iron
1-30th	....	....	no iron	·625 per ct.	$1\frac{3}{4}$ per ct.	4 per ct.	$\frac{1}{4}$ per ct.	no iron
1-25th	$9\frac{2}{10}$	$7\frac{4}{10}$						
1-20th	....	9	no iron	$8\frac{3}{4}$	$9\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{1}{4}$	no iron
1-15th	$12\frac{6}{10}$	13	$3\frac{1}{2}$ per ct.	$14\frac{1}{2}$	$12\frac{3}{4}$	$14\frac{1}{4}$	10	no iron
1-10th	unfused	unfused	$11\frac{6}{10}$	$23\frac{3}{4}$	$19\frac{1}{2}$	unfused	$25\frac{3}{4}$	3 per ct.
1-8th	....	....	....	....	....	....	....	$18\frac{1}{2}$
1-7th	....	....	$24\frac{8}{10}$	$27\frac{3}{4}$	unfused	....	$32\frac{1}{4}$	$26\frac{1}{2}$
1-5th	....	....	26	....	....	....	unfused	unfused

The following experiments, performed with argillaceous, siliceous, and calcareous ironstones in the state in which they are taken from the mine, exhibit an exact coincidence of effect with those artificially compounded.

1*st*, *Argillaceous Ironstone.*

Of this particular quality the mine presents three strata, each about $2\frac{1}{2}$ inches in thickness. They are found about 2 feet incumbent to a regular stratum of shelly limestone about 9 inches thick, and containing a thin measure of calcareous ironstone in its very centre. The shale or matrix in which the argillaceous strata are found, is a blackish blue clay in thin laminæ, and of that particular quality best calculated to stand the heat of a large furnace. Above this shale is found a small gritted sandstone, commonly called *water whin*, as hard as flint and about four feet thick.

The colour of the ironstone resembles very much the appearance of the schistus described above, only a few shades darker in point of colour. The fracture rough, and minutely granulated. Its hardness as an ironstone below mediocrity. A solitary muscle-shell is sometimes detected upon its surface; and on one piece I found an entire bivalve neatly forced open, with the configurations distinct. It may be proper to remark, that the measure of calcareous matter below is an entire coagulation of muscles; and further, that the under surface of the roof, rock, or sandstone, formerly mentioned, next to the matrix, is beautifully waved like the sea beach after flood tide. Irregularly dispersed along this surface are also found convex figures of small pine-shoots very perfect and entire. The matrix or shale below bearing the corresponding impression, with all the accuracy of a highly finished mould.

The specific gravity of this ironstone was*

Exp. I. 400 grains of raw ironstone were fused *per se*. The result was a dark coloured glass, the upper surface of which was covered with a film of oxide of a lake colour. Two small cavities were found formed, from which I inferred that the first portions of metal would be revived with a small dose of carbon.

Exp. II. 400 grains of raw ironstone,
5 —— of carbon, or 1-80th.

This mixture was reduced to a very beautiful shining black glass with a metallic lustre. Under it was found a very perfect spherule of iron which weighed exactly $8\frac{1}{2}$ grains, and equal in point of produce to $2\frac{1}{8}$ per cent.

The surface of this glass was imperfectly radiated with

* The author has omitted to fill up this blank.

configurations

configurations of a lake colour. The mass was uncommonly dense, and the fracture possessed a lustre beyond that of a highly finished razor-blade.

Exp. III. 400 grains of raw ironstone,
7 —— of charcoal, or 1-57th.

The fusion of this compound yielded an elegant spherule of iron which weighed $15\frac{1}{2}$ grains; equal to $3\frac{87}{100}$ per cent. The film of oxide upon the glass and the metallic lustre of the fracture nearly gone.

Exp. IV. 400 grains of raw ironstone,
10 —— of charcoal, or 1-40th.

This mixture formed a very perfect black glass, in the bottom of which was found a globule of iron which weighed 35 grains; equal to $8\frac{3}{4}$ per cent. The fracture of the glass, though small, presented a perfect crystallization, consisting of diverging lines crossed by light feathery impressions resembling hoar-frost.

Exp. V. 400 grains of raw ironstone,
20 —— of charcoal, or 1-20th.

There was obtained from the fusion of this mixture an oval mass of soft iron which weighed 59 grains: equal to $14\frac{3}{4}$ per cent. The film of oxide upon the surface of the glass was now nearly gone, and the colour a deeper black than in Exps. I, II, III, IV.

Exp. VI. 400 grains of raw ironstone,
$33\frac{1}{3}$ —— of carbon, or 1-12th.

This mixture was exposed to 160° of Wedgewood, and a perfect fusion was the result. Five grains of the charcoal, of a beautiful black colour, remained untaken up. A compact metallic button was found in the glass, which weighed 75 grains; and further, twelve small globules weighed two grains. Total 77 grains: equal to $19\frac{1}{4}$ per cent.

The glass was dull whitish green, minutely porous, and but slightly transparent. The film of oxide was entirely gone from the glass in this experiment.

Exp. VII. 400 grains of raw ironstone,
$44\frac{4}{10}$ —— carbon, or 1-9th.

This compound was fused at a high heat. The result was perfect. A metallic button was obtained which weighed 82 grains, and small globules thrown against the sides and cover of the crucible $2\frac{1}{4}$. Total $84\frac{1}{2}$ grains: equal to $21\frac{1}{10}$ per cent.

Exp. VIII. 400 grains of raw ironstone,
80 —— of carbon, or 1-5th.

This mixture was exposed till the crucible became soft, and

and nearly dropping. When cold I found the fusion incomplete, and could only collect in all 40 grains of iron.

Exp. IX. 400 grains of raw ironstone,
80 —— of charcoal,
100 —— of chalk.

This mixture fused with facility in a low heat. The result was a crystallized button of crude iron which weighed 112 grains; equal to 28 per cent.

Recapitulation of experiments with argillaceous ironstone.

						per cent.
Exp. I.	No metal revived.					
II.	1-80th	of carbon yielded		$8\frac{1}{2}$	grs. iron, or	$2\frac{1}{8}$
III.	1-57th	ditto	——	$15\frac{1}{2}$	ditto, or	$3\frac{87}{100}$
IV.	1-40th	ditto	——	35	ditto, or	$8\frac{3}{4}$
V.	1-20th	ditto	——	59	ditto, or	$14\frac{3}{4}$
VI.	1-12th	ditto	——	77	ditto, or	$19\frac{1}{4}$
VII.	1-9th	ditto	——	$84\frac{1}{2}$	ditto, or	$21\frac{1}{10}$
VIII.	1-5th	ditto	unfused.			
IX.	1-5th	ditto				
And 100 grains of chalk				112	ditto, or	28

A quantity of this argillaceous ironstone was torrified, and found to lose 31 per cent. It had then assumed a brownish red colour, which darkened considerably in pounding. It was found to be easily overheated in roasting, and then assumed a semi-vitrified fracture, losing its adhesion to the tongue. If the heat is carried to a faint white, the mass becomes of a blackish blue colour, swells up and resolves itself into the state of a honeycomb, increased in bulk and in weight.

Exp. I. 200 grains of this ironstone pounded was fused *per se*, and in the first experiment was found a minute globule of iron estimated at 1-3d of a grain. The experiment was twice repeated, but without any metal being revived. In the first case, therefore, the revival of the iron was most likely occasioned by a small portion of the fuel being accidentally thrown into the crucible.

Exp. II. 500 grains of roasted ore,
$12\frac{1}{2}$ —— of carbon, or 1-40th.

There resulted from the fusion of this mixture three perfect globules of iron which weighed 4 grains, which is about 8-10ths per cent. These were found in the bottom of an elliptical cavity possessed of the highest lustre and a variety of prismatic tints.

Exp. III. 400 grains of roasted ironstone,
44 —— of charcoal, or 1-9th nearly.

This

This mixture fused, and yielded a very perfect glass, accompanied by a metallic button which weighed 98 grains: equal to $24\frac{1}{2}$ per cent. The glass obtained was green, and possessed a flinty fracture.

Exp. IV. 400 grains of roasted ironstone,
80 —— of charcoal, or 1-5th.

This mixture was fused at a heat of 160°, and when cold was examined, and found as follows:

23 grains of charcoal were found upon the surface of a light green coloured glass, which covered a metallic button weighing	-	108 grains.
Globules extracted from the glass	-	6
Produce equal to $28\frac{1}{2}$ per cent.	-	114

Exp. V. 400 grains of roasted ironstone,
$133\frac{3}{10}$ — of carbon, or 1-3d.

This mixture was exposed to a heat of 162° of Wedgewood. When cold it was found imperfectly reduced. About 50 grains of metallic globules were obtained. A portion of glass was formed in perfect spheres, entirely covered with carburated globules of cast iron. The pulverulent matter that remained unfused was of a deep black colour mixed with spheres of very brilliant crude iron. This experiment was repeated as follows:

Exp. VI. 400 grains of roasted ironstone,
$133\frac{3}{10}$ — of charcoal, or 1-3d,
120 — of raw chalk.

This mixture was exposed in a much inferior heat, and a very perfect reduction of the compound obtained. A metallic button was found, and some globules, which weighed 142 grains; equal to $35\frac{1}{2}$ per cent.: which amounted to within $1\frac{1}{2}$ grain of the whole contents of iron contained in the ore.

These, with many other experiments, prove that when clay enters greatly into the compound of any ore, that carbon alone is not capable of reviving its metallic contents whether the ore is used in the raw or roasted state, and that calcareous earth, in almost every case, can be applied as a substitute in part for carbon in consequence of the curious relation it bears to both.

The difference betwixt the quantities of revived iron with 1-40th of carbon is sufficiently accounted for by the roasted ironstone containing 31 per cent. more of iron; of course the additional affinity exerted by this iron required an extra dose of carbon before any iron was let fall.

XXIII. *On*

XXIII. *On Prussiate of Copper.*

In our fourteenth volume, p. 359, we inserted a short paper by Charles Hatchett, esq. *On the Utility of Prussiate of Copper as a Pigment,* which was copied from the Journals of the Royal Institution, vol. i. p. 306. In the 1st number of the 2d vol. of that work, published the 1st of June 1803, was inserted a letter to Mr. Hatchett from Mr. Hume, of Long Acre, which we overlooked at the time, but which, in justice to both of these gentlemen, we now lay before our readers, some of whom may not have seen the work in which it originally appeared.

Letter to CHARLES HATCHETT, *Esq. respecting the Prussiate of Copper. From Mr.* HUME.

DEAR SIR,

On many accounts I have chosen to send the following communication to you, rather than lay it before the proper editor of the work to which it alludes; not doubting, if any public notice be deemed proper, your candour and your pen will do me at least as much justice as I deserve. In the last number of the Journals of the Royal Institution, I observe a paper, written with your usual chemical accuracy, on Prussiate of Copper, stating it to be very useful as a pigment, &c. I am very confident you were not aware, that the same substance, and for the very same purpose, had been many years before discovered and prepared by myself; that I have ever since constantly kept it for the use of some particular friends and artists; and have given away and sold of it to numberless other people, who, probably, never till now heard the name of prussiate of copper. I believe, amongst many others, two of the present proprietors of the Royal Institution will bear me out and testify to the truth of all this; viz. Mr. William Day, more particularly, and Mr. Collins, enamel painter to the king. The former gentleman will recollect that, more than ten years ago, I had made, indeed for a very different purpose than painting, a quantity of prussiate of copper; that on begging him to try it as a colour, a task he is very competent to, he approved of it and made a very favourable report, especially respecting its use in water. Indeed I dare say you are satisfied with this single proof; but I shall just add that, from my friend's recommendation, Mr. Collins began to use it, and has been supplied with it since more than once: the last

last parcel he had on the 2d of November last, which, to use his own words, "though an useful tint, is not so fine as that prepared two years ago."

Permit me to add, though in this place it may be irrelevant, that I have generally found good sulphate of copper answer best this purpose; and as this salt, from its cheapness, may possibly induce manufacturers to prefer it, the prussiate of lime must give place to that of potash or some other, since the former would form a simultaneous precipitate of sulphate of lime and prussiate of copper.

I remain, sir, Yours, &c.

JOS. HUME.

XXIV. *Second Letter to Mr.* TILLOCH *on the Cow-Pock, from Dr.* THORNTON, *being a Comparison of the Cow-Pox with the Small-Pox.*

Description of the natural Small-Pox, and of its Mortality.

THERE is no disease that the medical writer has to describe, which presents a more melancholy scene than the natural small-pox, as it very frequently occurs.

When the physician is first called to the bed-side of the patient, he is enabled at once to form a probable conjecture as to the approaching disorder, from the frequent sighings and sobbings of the person labouring under an anxiety he is unable to express; by pains felt in the region of the stomach, with an inclination, but generally an inability, to vomit; by the racking and frequent shooting pains along the back and loins; a general lassitude and aching of every limb; a most unpleasant sensation of cold, not relieved by any external warmth; a continued drowsiness, and disinclination to take food.

Then succeed heat, thirst, an inflamed eye, restlessness, or a constant inquietude; the pulse is quick and hard; convulsions now come on in children, and violent sweating in adults.

Such are the symptoms which usher in this dreadful foe to the human race, which now manifests itself by many speck-like spots, resembling flea-bites, which appear first on the face and upper parts of the body, and afterwards invade the whole trunk, look angry, create pain, and gradually elevate themselves above the skin, taking on the appearance of pimples. By the fifth or sixth day, these are converted

 into

into pustules, containing a transparent fluid, and each has an accompanying inflammation around.

At this period of the disease the throat becomes inflamed, and is painful; the breath is hot and fœtid; swallowing is difficult; the voice hoarse; in adults there comes on a salivation, and in infants a diarrhœa.

On the seventh day the eye-lids swell, and are glued together, and the patient has both the sensation and apprehension of the loss of sight.

On the eighth day the aqueous fluid of the pustules is changed into thick pus, and the effluvia now issuing from the patient are highly noisome and infectious; or, instead of a yellow pus, or matter, only ichor is produced, which erodes deep, and ends in mortification of the parts. Often, purple spots appear in the spaces surrounding the eruption, which forebode the approaching catastrophe. Often, profuse hæmorrhages of thin corrupt blood pass off by the several outlets of the body. The human face divine, bereft of every feature, then exhibits the most distressing sight, being one mass of corruption; and at this time, should sleep kindly come in to appease his miseries, it is disturbed and short, and he frequently wakes with a start, as if roused by some dreadful apprehension; but more generally the sleepless nights are passed in tearing off this mask of humours, which from a dark brown changes to a black, and each morning presents a horrid scene of gore mingled with corruption.

To behold the poor tortured victim muffled, resisting, and finally overcoming every artifice to prevent him tearing his flesh to pieces, is the most melancholy sight which the fond mother can witness. By-standers no longer recognize the temper or features of the lovely infant—happy if he escape without actual loss of vision, and the dimples of the cherub cheek are not furrowed into deep seams and unsightly pits. Parents at such a moment would willingly compromise every external grace for the possession of life. But fate yet hangs suspended on a thread. The swelling of the face abates; the limbs in their turn become tumefied; the fever, which had remitted somewhat of its first violence, recurs, from the matter absorbed; and the poor tortured victim, undergoing a second conflict more dreadful than the first, with weakened powers of resistance, most commonly from between the 14th to the 17th day (one out of three or four usually dying of the natural small-pox) finds a release from his miseries by the arrow of death, now esteemed as a kind deliverer, instead of the horror of the human conception. Or, if nature should come off victorious,

torious, how scarred! how each bone protrudes through the skin! how the limbs totter! how fretful the temper! how emaciated the countenance! how sunk the eye! how livid the flesh!

Perhaps even then the destroyer has still accomplished his work; and the patient, too early congratulated, sinks under a lingering consumption, or is eaten away by slow corroding ulcers, commonly called the king's evil, or scrophula.

Such is the too faithful picture of this loathsome disease, that baffles in description all the powers of language, and which destroys annually in Great Britain alone 50,000 souls, or throughout the habitable globe 20,000,000 of people, exclusive of those who perish from the impoverished state of the system, producing those formidable disorders which follow in her train.

1. *Of the Mortality occasioned by the Small-Pox.*

Ἥξει δὲ καὶ πολύπους
Καὶ πολύχειρ, ἁ δεινοῖς
Κρυπτομένα λόχοις
Χαλκόπους Ἐριννὺς.

Lo! with unnumbered hands and countless feet,
The FURY comes, her destined prey to meet;
Deep in the covert hid, *she glides unseen* — SOPHOCLES.

The reader may form some tolerable notion of the ravages committed by the small-pox, by examining the bills of mortality; for in London, where the climate is temperate, the disease well known, and the treatment of the sick very ably conducted, from 2000 to 3000, at the present day, annually perish.—*Baron Dimsdale.*

So great was the epidemic of the small-pox at Paris in 1723, that upwards of 20,000 perished in that city alone! —*Voltaire.*

In 1768, this same scourge destroyed at Naples 16,000 persons in a few weeks.—*Abbé Chappe.*

In Russia the annual destruction is estimated at 2,000,000. —*Baron Dimsdale.*

In China, where the population is immense, the number who annually die of the small-pox, the most loathsome, next to the leprosy, of all diseases, is incalculable.—*Dr. Clark.*

The fatality is still more remarkable among new people, who are wholly ignorant of the means of prevention, and the methods of cure.

The small-pox was first introduced into New Spain in 1520, by a negro slave, who attended Narvarez in his expedition

dition against Cortez. Torribio affirms, that one half of the people in the provinces visited with this distemper, died. The small-pox was not brought into Peru for several years after the invasion of the Spaniards; but there too that distemper proved very fatal to the natives.—*Garcia Origen,* p. 88. cited in *Robertson's Hist. of America,* vol. iii. p. 400.

About fifty years after the discovery of Peru, the small-pox was carried over from Europe to America, by way of Carthagena, when it over-ran the continent of the new world, and destroyed upwards of 100,000 Indians in the single province of Quito. This account was found by M. La Condamine, in an antient MS. preserved in the cathedral of that city. This author also observes, that in the Portuguese settlements bordering upon the River Amazons, the small-pox was nearly fatal to all the natives, *i. e.* original Americans.—See his *Mem. sur l'Inoc.* p. 61.

In 1767, never were so many people seen to die as at Kamtschatka, when a soldier introduced the small-pox for the first time; 20,000 perishing from that disease, and whole villages were observed nearly desolate.—*Cook's Voyage.*

The small-pox was first introduced into the frozen region of Greenland in 1733, when the mortality of this disease was so great, that it almost depopulated the whole country. —See *Crantz's History of Greenland,* vol. i. p. 336.

Even so late as the year 1793, when the small-pox was conveyed to the Isle of France, in the East-Indies, by a Dutch ship, five thousand four hundred persons perished there by this distemper in six weeks.—*Woodville,* vol. i. p. 28.

The Conclusion.

1. Hence it appears, that had the small-pox seized upon a person more than once during the period of life, the body being susceptible of more than one attack, as is the case with colds, fevers, agues, &c. either the human race would have presented a frightful spectacle of corroded scars and mangled deformity, or, what is more probable, would have become extinct, unless the inventive genius of man, assisted by God's mercy, had found out a mode to lessen the fatality and deformity occasioned by so formidable a disease, either by treatment, or some other means.

2. It is likewise evident from this statement, that all the wars throughout the whole world (an observation worthy the notice of the statesman) have never cut the thread of so many lives as this inexorable devourer of the human race, now happily, as will be seen in the following pages,

 chained

chained down, it is hoped, never more to turn her destructive fury on mankind, and strew the universe with dead bodies, mangled victims, and disconsolate mourners.

2. *Of the inoculated Small-Pox, and of its Consequences.*

The Result of these Cases is represented in the annexed Table, taken from Dr. Jurin.

AGES.	Persons inoculated.	Had the Small-pox by inoculation.	Supposed to have died of inoculation.
Under One Year ..	11	11	0
One to Two	15	14	2
Two to Three	31	31	1
Three to Four	41	38	1
Four to Five	33	31	1
Five to Ten	140	137	2
Ten to Fifteen	82	76	0
Fifteen to Twenty .	56	50	2
Twenty to Fifty-two	62	50	0
Age unknown	3	2	0
Total	474	440	9

Hence we find, that of the 474 persons first inoculated in England, *nine* died, and their deaths were not unjustly suspected to have happened in consequence of inoculation.

Of the natural small-pox, there usually dies one out of three; the difference is greatly in favour of the inoculated small-pox: but the question is not how individuals benefit, but the public at large. Is the mortality of the small-pox diminished?

The great and learned Dr. Heberden, in his observations on the increase and decrease of different diseases, observes, "that he examined carefully the bills of mortality, and comparing the destruction occasioned by the small-pox among our countrymen before and since inoculation, reluctantly was brought to this melancholy conclusion, that at the present period the *proportional increase* of deaths from this disease was as *five* to *four*."

Dr. Lettsom, when examined before the committee of the house of commons, stated, that he believed the inoculation of the small-pox, instead of benefiting society, had greatly increased the number of deaths. About the year 1773, he

 had

had paid particular attention to this subject, which afforded some observations applicable to the present inquiry, and decisive upon a large scale of calculation, which a table by figures more clearly evinced. The experience of forty-two years preceding the introduction of inoculation into this country, was already placed in a clear point of view in the Philosophical Transactions, by Dr. James Jurin, who was a sanguine advocate for inoculation, and whose testimony was therefore unexceptionable. His numbers were taken from the yearly bills of mortality, and the reason why the fourteen years from 1686 to 1701 were omitted, was, because in the bills of those years the account of the small-pox and measles were not distinguished, as in the preceding and following years, but were joined together in one article, so that from them no certain account could be drawn of the number of persons that died of the small-pox. It appeared by these tables, that out of 1,005,279 burials within the last forty-two years, 1742 *persons more* have *died* of the *small-pox* than the proportionate number, as collected from the experience of the first forty-two years: seventeen more burials therefore in one thousand had been occasioned by the small-pox, *since inoculation had been adopted.*

"Taking London and the out parishes as containing nearly 1,000,000 of people, he calculates, that 3000 probably died yearly by the small-pox, or eight every day; or allowing Great Britain and Ireland to contain 12,000,000 of people, no less than 36,000 annually. About *eight persons* die by the *small-pox every day* in the metropolis and its environs, or about *fifty-six* in each week."

The inoculation of the small-pox, therefore, increases instead of diminishing the number of burials.

This circumstance soon struck the discerning mind of Baron Dimsdale, who had the honour of being selected from among the faculty here, and went from England in order to inoculate the empress of all the Russias; which succeeding, besides a pension, he was made a counsellor of state, and physician to her imperial majesty.

Although every inducement led him to conceal the fact, yet, actuated by the love of truth, and patriotism towards a country to which he owed his promotion in life, he came forward to sound the alarm, and show how a seeming blessing was an actual evil to the state.

"Although the loss," says he, "under inoculation is very inconsiderable, *almost the whole* of those that are inoculated recovering, yet by spreading the disease, a greater proportion take it in the *natural* way: *more lives* are now

2 forfeited

forfeited in London than *before inoculation commenced*, and the community at large sustains a *greater loss:* the practice, therefore, is more *detrimental* than *beneficial* to society. In the last four years preceding 1776, the London bills from the small-pox arose at a medium to two thousand five hundred and forty-four: this increase is truly alarming. The disease by inoculation at the different public charities throughout London, would spread, by visitors, strangers, washerwomen, doctors, and inoculators; by means of hackney coaches, in which the sick are to be sent out to take the air, or by sound persons approaching them in the streets.

"The poor in London are miserably lodged; their habitations are in close alleys, courts, lanes, and old dirty houses: they are often in want of necessaries, even of bedding. The fathers and mothers are employed out constantly in laborious occupations, and cannot attend the inoculated sick: should they neglect their occupations, food and necessaries would be deficient, and the medicines ordered by the physicians would not be regularly complied with. The air in their houses is impure: they have neither areas, gardens, nor *carriages* for the convenience of ventilation and taking fresh air.

"Sailors and sea-faring people, many of whose lodgings are miserable in the little houses bordering on the river, would be liable to catch the distemper, and either to fall sick there without friends or assistants, or perhaps being infected on shore, to carry it to sea in their contaminated clothes, and afterwards falling sick without care or attendance, might spread the disease in foreign climates.

"Country people coming to town for markets, visits, or pleasure, would all be subject to the danger of infection. Persons coming from the sick to public charities, for medicines or advice, by intermixing in the streets, the *public* danger from their infected apparel would be *great* and inevitable: the whole neighbourhood would be exposed, and in imminent danger, by having the small-pox brought to their doors. The gossiping disposition of the poor will spread it further; and after the sick recover, sallying forth in their infected clothes is certain to add to the mischief. The children who are able to run about will intermingle in the streets, immediately upon their recovery, with their playfellows: the success therefore derived from inoculation must be beneficial to a *few* only, but involve a great number of others in danger, to which they would otherwise be less exposed."

Dr. Heberden observes, "That the poor form the largest part of mankind, and only consider the present moment;

 and

and their prejudices are strong, and not to be overcome by reason. Hence, while the inoculation of the wealthy keeps up a perpetual source of infection, those who either do not choose, or cannot afford expense, are more exposed to this distemper. The danger also is increased by the custom of sending persons into the open air in every stage of the disease. Hence, while *inoculation* may be justly esteemed as one of the greatest improvements ever introduced into the medical art, it occasions a greater sacrifice of life by what has been distinguished by the appellation of the *natural* small-pox."

As a proof of this position, we have the following record from a most diligent and careful observer of facts, Dr. Willan, in his account of the diseases in London.

"A child having been inoculated in a court (whose parent kept a chandler's-shop) consisting of twenty houses; the consequence was, that in this court seventeen persons took the natural small-pox, although the season was kind (April); and *eight* of these died.

"They in their turn became the focus of fresh infection, and thus a private good was converted into a public evil."

3. *Description of the inoculated Cow-Pock.*

First, of the Pustule.—4th day, A rising pimple containing a fluid; the apex elevated.—8th day, A circular even-edged, flat, uniform pustule, containing a fluid in cells; the apex a scab; circular inflammation.—10th day, Pustule enlarged with many small depressions; its central part converting to a scab; fluid still transparent; the central scab increased, and of a mahogany colour; hardness and circular inflammation.—13th day, The central scab increased in size, of a dark mahogany colour; the circle of the pustule, as seen on the 10th day, completely converted into a hazel-coloured scab; scarcely any fluid; inflammation deadened.—14th day, Almost all the pustule converted into a hazel-coloured scab, surrounding the dark mahogany central scab; scarce any containing fluid, and that only in the circumference, which has lost its blue tinge, and looks brown.—15th day, The whole pustule converted into two distinct scabs; no fluid; a white ring surrounding the pustule from the peeling away of some dead cuticle.—16th day, More white concentric rings from the same cause, and the hardness and inflammation greatly subsided.

These appearances may vary according to constitutions; they were drawn under my eye, from examinations made on

two

two of my own children, and tolerably correctly characterize the usual stages of the cow-pock.

The cow-pock pustule is distinguished from the small-pox pustule from the following differences:

In the *small-pox* the inoculated pustule is angulated, and numerous pustules surround it; in the *cow-pock,* the pustule has its edges regularly circumscribed, and stands solitary; the *small-pox* pustule contains first a fluid, then opaque matter; the *cow-pock* pustule a gelatinous fluid, which never becomes converted into pus; the edges of the *one* are more elevated, in the *other* more depressed; the scab is also much darker and harder in the *cow-pock.*—(*Jenner.*)

The fluid of the *cow-pock* is like the juice of an orange, in blebs; of the *small-pox,* in a single cavity. The *one* may be inoculated upon, and is the disease of animals; whereas the *small-pox* seems peculiar to the human race, and can be engrafted, as John Hunter's experiment proves, upon no animal.

When the cow-pock is inoculated, it never produces an irruptive disease like the other, but usually only a local pustule.

Dr. Woodville, in his public report on the cow-pock, observes, "That of the last two thousand cases of cow-pock under my care, not a single alarming symptom was excited; and I may now add, that during the last eight months I have not met with one instance of the vaccine disease, which has not been as favourable as the mildest cases of variolous inoculation. I have no doubt, therefore, that the inoculated cow-pock is *as much milder* than the inoculated small-pox, as the latter disease is milder than the casual small-pox: nay, it seems to me from the very benign form in which the vaccine pock has of late invariably appeared, that it may be considered as a disease perfectly *harmless* in its effects."

Dr. Willan, in his general report of the diseases of London, says, "Few or none of the out-patients of the hospital, inoculated with the vaccine pock, have pustules over the body." Dr. Woodville likewise observes, (Observations on the Cow-Pock, page 24,) "In my private practice of inoculation for the cow-pock, which has been very extensive, I have not met with one instance in which any pustules, resembling those of the small-pox, appeared." My own experience coincides perfectly with this statement, in different families I have seen inoculated with vaccine fluid, occasionally selected by myself at the hospital, and taken on new lancets, about sixty persons, none of whom had pustular eruptions*, at the maturation of the pock formed by the

* In one child, three minute hard tubercles appeared on the fore-arm about

the puncture. Patients admitted into the inoculation hospital have often pustules on the body, after vaccine matter has been inserted in the arm, from the following cause: They are mostly persons from the country, who, alarmed on finding some of the inhabitants of the houses where they lodge, or visit, affected with the small-pox, endeavour to anticipate the disorder by means of inoculation, at some asylum opened to them by public benevolence. But the application is probably too late: some of them have already received the infection, and, before the vaccine pock can reach the end of its second stage, an eruption of variolous pustules takes place in the usual manner. In attending at the hospital last summer, while Dr. Woodville was on his mission to Paris, I observed four instances of persons so circumstanced, in whom the eruptions appeared, on different days, between the third and the eighth from inoculation*.

The cow-pock producing no pustules, no quantity of fluid is re-absorbed into the constitution, producing a secondary fever, as is often in small-pox, and the constitutional affection is also much slighter, when it occurs, than with the small-pox.

The small-pox when inoculated, or taken naturally, usually is ushered in by convulsion in children at all ages. " Paint to yourself," says Dr. Macdonald, " one of these little innocent sufferers, stretched out, and covered with one continued sore; threatened with suffocation, uttering the agonies he feels by piercingly heart-wounding groans.—Observe how his mouth foams; listen to the grinding of his teeth; see how he thrusts his little trembling tongue betwixt them, and how piteously it is wounded!—Look! how he is agitated with the most dreadful convulsions! his feeble limbs are twisted and contorted, and threaten dislocation; his frame bends backwards; is lifted up and thrown down again!—These fits now increase,—then cease, alas! only to return with redoubled violence.—Misery calls aloud for help, help;—but calls in vain.—New convulsions succeed;—he foams,—struggles, gasps,—gasps again,—and expires!"

The cow-pock is never ushered in by convulsions.

about the seventh day, but they subsided in two or three days. This little eruption was merely the strophulus candidus, described in the Treatise on Cutaneous Diseases, page 32.

* From this cause some confusion arose in Dr. Woodville's first reports; for, from inoculating at the same time with variolous matter, and sometimes from the contagion of the small-pox, pustular cases were not unfrequently produced.

[To be continued.]

XXV. *Seventeenth*

XXV. *Seventeenth Communication from Dr. Thornton, relative to Pneumatic Medicine.*

To Mr. Tilloch.

Nov. 10, 1804,
N . 1, Hinde-street, Manchester-square.

DEAR SIR,

I HAVE the honor to enclose you the following very striking case for the information of the philosophic world:

Case of Chronic Herpes cured by the Vital Air.

Mr. Thomas Clutterham, glover, now residing at No. 3, Thayer-street, Manchester-square, was a patient of mine so far back as September 1796; and he had been afflicted, he believes, from his cradle with a general humour extending nearly over the whole surface. Various remedies had been used at different times, but to no purpose, under very able practitioners. His disease appeared to me to be confirmed herpes (impetigo scabida of the very accurate Dr. Willan), and his face, when I first saw him, looked very like one labouring under the small-pox, being one general incrustation. The eruption, as I observed before, was also diffused over the whole body. This disease had now existed *twenty-three* years. I ordered him to continue the use of the same remedies, before found ineffectual; as bark and steel, and, in addition, he inhaled the *vital air*,—a gallon to four of atmospheric air twice in the day,—and continued this for three months, without intermitting a day (Sundays included), when the eruption, gradually declining, was wholly conquered, and I pronounced him, I hoped, permanently *cured.*

Observations on this Case.

1. The patient is now before me (November 20, 1804), and says "he has enjoyed excellent health ever since, and has had no eruption of any kind, either in the face or any part of the body; nor has he taken any medicine whatever since."

2. He remembers "that the vital air very much increased his appetite; that he ate more hearty during its administration than at any former, or even at the present period."

3. "His spirits were raised in consequence."

4. Is not the *rationale* of this remarkable cure as follows? The vessels on the surface were torpid in their powers; but when the heart was roused to increased action by the vital air,

air, these were set into better motion, and the stagnated fluids absorbed, and more *vis vitæ* thrown on the surface, sufficient to remove cutaneous obstructions; and, aided by tonic medicines, the disease vanished.

5. *Query*—Would the *vital air* alone have effected so extraordinary a cure? or *medicines?*—It is from *combined powers* that I believe the benefit arose, as I have before endeavoured to explain in some other cases.

I have the honour to remain,
Dear sir,
Your faithful, obliged friend,
ROBERT JOHN THORNTON.

XXVI. *On Cerium, a new Metal found in a Mineral Substance of Bastnas in Sweden, called Tungsten, described by* W. D'HISINGER *and* J. B. BERZELIUS*.

I. *Description of the Tungsten of Bastnas.*

THOUGH this substance was formerly tried by Scheele and D'Ellhuyar, under the name of wolfram, yet its considerable specific gravity determined us to subject it to further researches. Our object in particular was to find yttria, which, being unknown at the time when these chemists carried on their labours, might have escaped their attention. Our suspicions were ill-founded; since, instead of an earth, we found in it, according to every appearance, a substance hitherto unknown, as will be seen by what follows:

The tungsten of Bastnas, which we call cerite, for reasons which will be hereafter mentioned, was found in the year 1750, in a copper mine called Bastnas, or Saint Gorans Koppargrufva, at Riddare-Hyttan, in Westmannia, of which it formed with asbestos the matrix; but after that time it was inclosed in quartz and mica, at the depth of seventeen toises.

Tungsten is almost always mechanically mixed with black amphibolite (hornblend), striated actinote, of a bright green colour (schorl), with mica, sulphurated copper, bismuth, and sulphurated molybdena, as one may be more readily convinced by exposing it to the fire.

Cerite, properly so called, is transparent, of a flesh colour, sometimes dark, sometimes bright, and rarely yellow. The stone in a mass, and in small specimens, is of an irregular

* From *Annales de Chimie*, No. 150.

form;

form; its fracture is indeterminate, compact, and somewhat brilliant; the edges obtuse; its consistence is tenacious and strong; it strikes fire with difficulty, but it does not scratch glass; it is not susceptible of attraction by the magnet; but when it has been brought to a red heat in the fire, it loses its hardness and six or seven per cent. of its weight. By this operation it becomes friable, and assumes a bright yellow colour; it does not fuse alone.

Cronstedt, in his Mineralogy, places it, in consequence of its specific gravity, among the tungstens. In pure fragments its weight is to that of water, as 4733 and 4935 to 1000. As Scheele did not find wolfram in it, he called it false tungsten.

According to an analysis of D'Ellhuyar, the constituent principles of this mineral were given by Bergmann, in the Memoirs of the Academy for the year 1784, p. 121, as follows:

Silex	-	022
Iron	-	024
Lime	-	054
		100

Heated by the blow-pipe with borax, it forms a glass globule, which, when warm, appears greenish, but colourless when it has cooled. When fused with carbonate of soda, in a platina spoon, it is not dissolved.

II. *Analysis of Cerium.*

To separate the yttria, which it was suspected to contain, it was reduced to a fine powder in a porphyry mortar, and pure concentrated nitric acid was then added to it. The acid was decomposed, and a considerable quantity of nitrous and carbonic acid gases was disengaged. The stony powder was several times treated with acid, until the insoluble residuum appeared white.

The solution, diluted with water, had a yellow colour, which became greenish by ebullition, and then red;—when dried completely, it became yellowish white; but by attracting humidity it resumes its red colour.

In alcohol it is entirely dissolved, and the solution, when slightly digested, deposits a considerable quantity of oxide of iron. It deposited also more oxide of iron during a rest of some days in a window. The solution decanted, being almost clear, was evaporated to dryness, and the salt calcined exhibited a powder of a brick colour. Water was able

able to dissolve only the calcareous earth. Distilled vinegar became charged only with a very small portion, and was not saturated, though assisted by the heat of ebullition. The acetic solution, when evaporated, gave small granulated crystals, of a saccharine and astringent taste. They were not soluble in alcohol. The part of the acetous salt, which was not dissolved by alcohol, gave, after calcination, a powder of a brick colour, similar to that which had not been dissolved.

Ammonia precipitated from the solution of the alcohol a white powder, which became yellowish in the air. It was a little soluble by carbonate of ammonia, and, by calcination, assumed a brick colour. The sediment being separated, the carbonate of ammonia produced a white precipitate, which was pure carbonate of lime. The acetous salt then contained no yttria. The powder from which the calcareous earth had been separated, dissolved in muriatic acid, disengaging oxygenated muriatic acid gas, which indicated that it was a metallic oxide.

Was it oxide of manganese united with oxide of iron?

To ascertain this, we tried to develop the pure oxide from the manganese by means of the tartrite of potash, according to the method of Richter. In this manner we decomposed with tartrite of potash a solution of this substance in muriatic acid perfectly neutralized, and, after having well washed the white precipitate, we subjected it to slow calcination: but this produced only powder of a brick colour.

Caustic alkali had no action on the insoluble part of the nitrate; which proves that it contained no alumine.

To obtain the metal pure in a sufficient quantity for making several trials, we dissolved another portion of cerite in nitric acid, and evaporated the solution to dryness. Water was then poured over the residuum, and the whole was precipitated by ammonia. The precipitate when washed was dissolved in nitric acid. The solution, when well neutralized by alkali, was precipitated by the tartrite of potash. There was precipitated also from the same solution, by carbonate of potash, a white powder, but in small quantity. Both these precipitates were calcined separately, and both assumed a brick colour. The precipitate formed by the carbonate of potash was not dissolved by the potash with the assistance of digestion; there was therefore no alumine in it. The iron which the solution precipitated by the tartrite of potash contained, was separated by the hydro-sulphuret of ammonia. The rest of the solution of the

the cerite in nitric acid, which had been precipitated by caustic ammonia, gave by carbonate of ammonia carbonate of lime.

It results from these trials that cerite contains nearly 23 parts of silex, 5·5 of carbonate of lime, 22 oxide of iron, and a quantity of that matter in a metallic state; the weight of which after calcination exceeded, a little, 50 per cent. But this substance being then, as well as the iron, united with more oxygen than they contained in the cerite, instead of loss we had an increase of gravity, which in all probability arose from the oxygen. The loss which the cerite had experienced by calcination is not here included. We thus found traces of manganese, but in a quantity so inconsiderable that the potash fused with cerite and dissolved in water exhibited no colour.

Not having much experience in regard to complete analysis, as far as quantity is concerned, we give these results only with reserve, and in the hope that more expert chemists will employ themselves on this object.

III. *Examination of the metallic Oxide found in Cerite.*

With 37 grains of this oxide and linseed oil we made a paste, which was reduced to charcoal in a covered crucible. It lost half a grain of its weight. This mass was inclosed in a crucible of charcoal without flux: and M. Hjelm exposed it for half an hour to such a degree of heat as would be necessary for the reduction of manganese. The oxide was not fused, but reduced to a very fine powder: it exhibited to the light brilliant particles, and stained white paper black. It dissolved in muriatic acid, disengaging at the commencement sulphurated hydrogen gas, and then pure hydrogen gas. This colourless solution had a saccharine taste. It therefore appeared to us that the metal was in part reduced. One may find the origin of the sulphur in the sulphuric acid from which the matter had been separated by caustic ammonia. It will be seen by further researches what influence this acid has in these trials.

M. Gahn, of Fahlun, having a proper apparatus, promised to us to undertake the reduction of this substance with more force. If this operation be attended with success, we shall give an account of it hereafter.

These and the following circumstances have determined us to consider the substance found in cerite as the oxide of a metal hitherto unknown, to which we have given the name of *cerium*, from the planet Ceres discovered by Piazzi.

Method

Method of obtaining Oxide of Cerium.

(A.) Dissolve pure cerite, not calcined, in nitro-muriatic acid, and, having saturated the clear solution with alkali, precipitate it by tartrite of potash. The precipitate, when well washed, calcined, and digested in vinegar, contains pure oxide of cerium.

Or decompose a solution of cerium in nitro-muriatic acid, still warm, but not saturated by succinate of ammonia: a succinate of iron is gradually deposited. Continue this precipitation by muriate of ammonia until a white precipitate appears. Leave the solution at rest, in order that the small portion of succinate of cerium may be deposited. The iron dissolved by the free muriatic acid deposits itself at the same time, and the solution is obtained free from that metal. You may then precipitate the cerium with ammonia, and wash and calcine it.

Of the Properties of Oxide of Cerium.

(B.) This oxide may appear under different degrees of oxidation. Alkalies precipitate from its solutions a white oxide, which in the air has a yellowish colour, but which when perfectly dry becomes dark. When exposed to a strong heat, long continued, it assumes a dark brick colour. The oxalate and acetate of cerium, when calcined in vessels not completely shut, give a white oxide, which on an open fire becomes of a brick colour. It does not fuse alone.

Treated by the blowpipe with borax, it readily fuses and swells up. The globule struck, by the external flame, assumes a blood colour, which by cooling passes to a greenish yellow, and at length becomes colourless and acquires complete transparency. Fused by the interior flame, these changes do not take place: it is then reduced to colourless glass, but when exposed a little time to the exterior flame the same phænomena are exhibited. If too much oxide of cerium be employed, the glass resembles yellowish opake enamel. These changes are manifested more readily with phosphates of soda and of ammonia. If two clear colourless globules, one of which is made with borax and the other with phosphate, be fused together, they give a transparent glass, which on cooling becomes of an opake pearl colour.

These characters taken together distinguish oxide of cerium from oxide of iron. The latter presents the same changes of colours; but its glass, after it has been cooled, has a dark green fugitive colour.

The globules of borax and phosphate fused together give an opake glass, the colour of which is a little darker.

[To be continued.]

XXVII. *Me-*

XXVII. *Method of giving the Grain and Hardness of Steel to Copper.* By B. G. Sage*.

Margraff and Pelletier have published their researches on the union of phosphorus with different metallic substances: the French chemist has improved this process, and it was by repeating and varying his experiments that I discovered that the surest and speediest means of phosphorizing copper was to take the metal under the metallic form, to fuse it with two parts of animal glass, and a twelfth of charcoal powder; but it is essential that the copper should present a great deal of surface,—an advantage obtained by taking shavings of that metal, which are placed in strata with animal glass mixed with charcoal powder. I expose the crucible to a fire sufficiently strong to fuse the animal glass. There is then formed phosphorus, the greater part of which burns, while another combines with the copper, in which it remains incarcerated till no more is disengaged, though kept in fusion for twenty minutes under the animal glass which has not been decomposed.

When the crucible has cooled, and is broken, the phosphorated copper is found in the form of a gray brilliant button under the glass, which has passed to the state of red enamel. On being weighed, it is found that by this operation its weight has been increased a twelfth.

If the phosphorized copper, when fused, falls on a plate of polished iron, it extends itself over it in the form of plates differently figured, which exhibit the play of colours of a pigeon's neck.

The phosphorized copper is much more fusible than common copper: it may often be fused under charcoal powder without losing any of its properties.

The same phosphorized copper, when exposed a long time under the muffle, separates only with great difficulty from the phosphorus.

The copper thus combined with phosphorus acquires the hardness of steel, of which it has the grain and the colour: like it, it is susceptible of the finest polish; it can be easily turned; it does not become altered in the air. I have kept buttons of polished phosphorized copper in my laboratory for fifteen years, without their experiencing any alteration. The copper emits no smell when rubbed. Were it ductile, it would be of the greatest utility, since no fat bodies seem to have any hold of it.

* From the *Journal de Physique*, Messidor, an 12.

In the phosphorization of copper there is only a part of the animal glass decomposed, because a quantity of charcoal necessary to phosphorize the whole acid has not been employed: but it is necessary that this should be the case in order that the vitreous scoria should be sufficiently fluid for the phosphorus to be disengaged and to collect itself readily.

The dark red enamel which is formed in this experiment may be employed with advantage for porcelain and enamels, as this red does not alter in the fire.

Copper can combine with phosphorus only in the dry way. If a cylinder of phosphorus be put into a solution of nitrate of copper diluted with four or five thousand parts of water, copper under the metallic form will be found at the end of eight days crystallized and ductile, forming a case to the cylinder of phosphorus.

XXVIII. *On Phosphoric Acid and Phosphorus.* *By* Jos. Hume, *Esq.*

To Mr. Tilloch.

DEAR SIR,

At the request of a medical friend of mine, I lately made some experiments with a view to form a comparative estimate between healthy urine and some of a peculiar morbid nature.

In this analysis, amongst other observations which occurred, I found that acetite of lead is by no means to be depended on as the best test for phosphoric acid; that it is liable to induce error; and in many instances where it has been trusted to ascertain the quantity of the acid, the accuracy of the results may be suspected, especially where the subject did not consist of a simple phosphate.

If my professional avocations permit, I shall endeavour to extend many of these remarks, and fit them, under some arrangement, for a future number of the Philosophical Magazine. It may be proper, however, to acquaint you, that the substitutes I employed in lieu of acetite of lead, were nitrates of lead, of barytes, or of zinc; and some other metallic salts which need not be named.

In point of œconomy and efficacy nitrate of lead is vastly superior to the acetite for the most exact and complete separation of phosphoric acid: hence in all cases whatever it ought to be universally preferred in the preparation of phosphorus.

With

With regard to the value, nitrate of lead may, I presume, be manufactured at less than 4-5ths of the price of the acetite. The last we know requires that the lead be previously prepared and oxidated; and much time is spent in the operation: on the contrary, the nitrate may be made directly from the metal itself in the metallic state.

When phosphate of soda was decomposed by these metallic salts, I found invariably a material difference in favour of nitrate of lead: for 100 grains of the nitrate decomposed 120 of the neutro-saline salt; whereas 100 of the acetite of lead required but 77 grains of the same phosphate.

The metallic phosphate formed by the nitrate of lead and phosphate of soda was pure; but that procured by the acetite was contaminated with an oxide, or a kind, as I suspect, of sub-acetite of the metal; and this circumstance alone decidedly urged me to reject it as a test, and to abide by, and rely on, nitrate of lead alone in every future analysis.

I know both of these metallic salts have been proposed for the preparation of phosphorus; but in no work whatever, especially of the elementary kind, has any decided preference been bestowed on the nitrate of lead: on the contrary, the acetite is generally prescribed even by authors of the most modern date.

These remarks naturally point out the most frugal method to procure phosphorus: the process, therefore, I should prefer is briefly this:—

To decompose phosphate of soda by nitrate of lead; to wash and separate the metallic phosphate; and, in the usual manner, by means of charcoal, distil off the phosphorus.

I have chosen phosphate of soda, in order to procure the phosphorus quite pure; as I apprehend, without great caution, some sulphates may exist when the acid is prepared from bones, agreeably to Nicholas de Nancy's process, and may eventually be converted into sulphur, which, we know, will rise and distil over with the phosphorus. This suspicion was entertained by my much respected friend the late Mr. Woulfe.

In many places, such as in garrisons, several public establishments, and amongst manufacturers, where urine might be collected with more decency, an immense quantity of phosphate of lead may be formed daily, and returned for a quantity of nitrate of lead, with which they should be furnished for the purpose. I need not say this is Giobert's process, that of decomposing the phosphates in urine; such as are capable of it, by nitrate of lead too. I am surprised

it has not only been little noticed, but absolutely seems to have been rejected from general practice.

By sundry experiments I have ascertained, that, on an average, from 300 to 500 grains of phosphate of lead may be daily obtained from the urine generated by one healthy individual; by employing, for that purpose, a solution of nitrate of lead.

Very pure phosphoric acid may likewise be commodiously manufactured by means of nitrate of barytes. The phosphate thus formed is to be, in its turn, decomposed by sulphuric acid.

This process applies equally to separate the phosphoric acid from urine, or from the impure acid obtained from calcined bones.

After bones have been calcined and powdered, they should invariably be washed before the affusion of sulphuric acid, that no neutral soluble salt remain: this operation may be readily performed by suspending the pulverised ashes in a large quantity of water; and this method deserves to be followed on many other occasions. I remain, sir,

Your obedient servant,

JOS. HUME.

Long Acre,
Nov. 19, 1804.

XXIX. *On two Metals, found in the black Powder remaining after the Solution of Platina.* By SMITHSON TENNANT, *Esq. F. R. S.**

UPON making some experiments, last summer, on the black powder which remains after the solution of platina, I observed that it did not, as was generally believed, consist chiefly of plumbago, but contained some unknown metallic ingredients. Intending to repeat my experiments with more attention during the winter, I mentioned the result of them to Sir Joseph Banks, together with my intention of communicating to the Royal Society my examination of this substance, as soon as it should appear in any degree satisfactory. Two memoirs were afterwards published in France, on the same subject; one of them by M. Descotils, and the other by Messrs. Vauquelin and Fourcroy. M. Descotils chiefly directs his attention to the effects produced by this substance on the solutions of platina. He remarks, that a small portion of it is always taken up by nitro-muria-

* From the *Transactions of the Royal Society of London for* 1804.

tic

tic acid, during its action on platina; and, principally from the observations he is thence enabled to make, he infers, that it contains a new metal, which, among other properties, has that of giving a deep red colour to the precipitates of platina.

M. Vauquelin attempted a more direct analysis of the substance, and obtained from it the same metal as that discovered by M. Descotils. But neither of these chemists has observed, that it contains also another metal, different from any hitherto known.

The substance with which my experiments were made, was obtained from platina which had been previously freed from the sand and other impurities generally mixed with it; so that it must have been contained in the substance of the grains of platina. Though it has somewhat the appearance of plumbago, it may easily be distinguished by its superior weight. By weighing it in a phial with water, I found its specific gravity almost 10·7.

Before I describe the method of separating the two metals of which it consists, it may be worth while to mention the effects of it, when combined with different metals in an entire state. It readily unites with lead; but, even with ten times its own weight, the compound has not, when melted, much fluidity. Upon dissolving the lead in nitrous acid, the black powder was obtained, with little apparent alteration, not having been entirely broken down, but consisting chiefly of the same scaly particles as at first. With bismuth, zinc, and tin, the effects were nearly similar; but, by fusion with copper in a very strong heat, a more perfect union was produced. On attempting to dissolve the compound by nitro-muriatic acid, some of the powder was taken up with the copper, forming a very dark solution.

The undissolved portion consisted partly of the substance in its original form of scales, and partly of a blacker powder, the particles of which were too small to be visible, and which had probably been completely combined with the copper. This substance may be easily united, by fusion, with silver or gold; and it is particularly deserving of attention, that it cannot be separated from these metals by the usual process of refining. It remains combined with either of them, after cupellation with lead; and with the gold, after quartation with silver. The alloys retain considerable ductility; and the colour of that with gold is not materially different from pure gold.

I shall now proceed to describe the analysis of the black powder, and the properties of the two metals which enter

 into

into its composition. The method which I used for dissolving it, was similar to that employed by M. Vauquelin; the alternate action of caustic alkali, and of an acid. I put a quantity of the powder into a crucible of silver, with a large proportion of pure dry soda, and kept it in a red heat for some time. The alkali being then dissolved in water, had acquired a deep orange, or brownish-yellow colour, but much of the powder remained undissolved. This powder, digested in marine acid, gave a dark blue solution, which afterwards became of a dusky olive-green, and finally, by continuing the heat, of a deep red colour. Part of the powder, being yet undissolved by the marine acid, was heated as before with alkali; and, by the alternate action of the alkali and acid, the whole appeared capable of solution. At each operation some silex was taken up by the alkali; and, as this continued till the metallic part was entirely dissolved, it seems to have been chemically combined with it.

The alkaline solution contains the oxide of a volatile metal, not yet noticed, but which I shall presently describe, and also a small proportion of the other metal. If this solution is kept for some weeks, the latter metal separates spontaneously from it, in the form of very thin flakes, of a dark colour.

The acid solution also contains both the metals, but principally that which has been mentioned by the French chemists. The properties of this last metal, which they have remarked, are those of giving a red colour to the triple salt of platina with sal-ammoniac, of not being altered by muriate of tin, and of giving, with pure alkali, a dark brown precipitate. M. Vauquelin also adds, that it is precipitated by galls, and by prussiate of potash; but I should rather ascribe these precipitates to some impurity, and probably to iron.

As it is necessary to give some name to bodies which have not been known before, and most convenient to indicate by it some characteristic property, I should incline to call this metal *iridium*, from the striking variety of colours which it gives, while dissolving in marine acid.

In order to obtain the compound of this metal with marine acid in a pure state, I tried to make it crystallize.

By slow evaporation of the solution, only an imperfectly crystallized mass was produced; but this, being dried on blotting-paper, and dissolved in water, afforded, by again evaporating as before, distinct octaëdral crystals. These crystals, dissolved in water, gave a deep red coloured solution, inclining to orange. With an infusion of galls, no precipitate was formed, but the colour was instantly, and almost

almost entirely, taken away. Muriate of tin, carbonate of soda, and prussiate of potash, produced nearly the same effect. Pure ammonia precipitates the oxide; but (possibly from adding it in excess) I found it retained a part in solution, acquiring a purple colour. The pure fixed alkalis also precipitate the greater part of the oxide, but are capable of retaining a part in solution, becoming of a yellow colour. All the metals which I tried, excepting gold and platina, produced a dark or black precipitate from the muriated solution, which is at the same time deprived of its colour. The iridium may be obtained in a pure state, merely by exposing the octaëdral crystals to heat, which expels the oxygen and the muriatic acid. It appeared of a white colour, and was not capable of being melted by any degree of heat I could apply. I could not combine it with sulphur nor with arsenic. Lead easily unites with it; but is separated by cupellation, leaving the iridium upon the cupel, as a coarse black powder. Copper forms with it a very malleable alloy, which, after cupellation with the addition of lead, left a small proportion of the iridium, but much less than in the former case. Silver may be united with it, and the compound remains perfectly malleable. The iridium was not separated from it by cupellation, but occasioned on the surface a dark or tarnished hue. It appeared not to be perfectly combined with the silver, but merely diffused through the substance of it, in the state of a fine powder. Gold alloyed with iridium is not freed from it by cupellation, nor by quartation with silver. The compound was malleable; and did not differ much in colour from pure gold, though the proportion of alloy was very considerable. If the gold or silver is dissolved, the iridium is left, in the form of a black powder.

The yellow alkaline solution, which I have already mentioned as containing a metallic oxide, distinct from the former, is considered by M. Vauquelin as a solution of the oxide of chrome in alkali; but I could not, by any test, discover the presence of chrome. After the superfluous alkali had been neutralized by an acid, it produced a pale or buff-coloured precipitate with a solution of lead, and not the bright yellow which is given by chrome. But, as we are indebted to the above distinguished chemist, among many other important discoveries, for our knowledge of the existence of chrome, it is not improbable that some kinds of platina may contain that substance, besides the other bodies usually mixed with it. When the alkaline solution is first formed, by adding water to the dry alkaline mass in the crucible, a pungent and

 peculiar

peculiar smell is immediately perceived. This smell, as I afterwards discovered, arises from the extrication of a very volatile metallic oxide; and, as this smell is one of its most distinguishing characters, I should on that account incline to call the metal *osmium*.

This oxide may be expelled from the alkali by any acid, and obtained in solution with water by distillation. The sulphuric acid, being the least volatile, is the most proper for this purpose; but as, even of this acid, a little is liable to pass over, a second slow distillation is required, to obtain the oxide perfectly free from it. The solution thus procured is without colour, has a sweetish taste, and the strong smell before mentioned. Paper stained blue with violets, was not changed by it to red; but, by being exposed to the vapour of it in a phial, the paper lost much of its blue colour, and inclined to gray. As a certain quantity of this oxide is extricated during the solution of the iridium in marine acid, that part may also be obtained by distillation.

Another mode by which the oxide of osmium may be obtained in small quantity, but in a more concentrated state, is, by distilling with nitre the original black powder procured from platina.

With a degree of heat hardly red, there sublimes into the neck of the retort a fluid apparently oily, but which, on cooling, concretes into a solid, colourless, semitransparent mass. This, being dissolved in water, forms a solution similar to that before described. The oxide, in this concentrated state, stains the skin of a dark colour, which cannot be effaced. The most striking test of the oxide of osmium, is an infusion of galls, which presently produces a purple colour, becoming soon after of a deep vivid blue. By this means, the presence of this, and of the metal first described, may be observed, when the two are mixed together. The solution of iridium is not apparently altered by being mixed with the oxide of osmium; but, on adding an infusion of galls, the red colour of the first is instantly taken away, and soon after the purple and blue colour of the latter appears. The solution of the oxide of osmium with pure ammonia, becomes somewhat yellow, and slightly so with carbonate of soda. It is not affected by pure magnesia, nor by chalk; but with lime a solution is formed of a bright yellow colour. The solution with lime gives with galls a deep red precipitate, which becomes blue by acids. It produces no effect on a solution of platina or gold; but precipitates lead of a yellowish-brown, mercury of a white, and muriate of tin of a brown colour.

The oxide of osmium becomes of a dark colour with alcohol, and, after some time, separates in the form of black films, leaving the alcohol without colour. The same effect is produced by ether, and much more quickly.

This oxide appears to part with its oxygen to all the metals, excepting gold and platina. Silver being kept in a solution of it for some time, acquires a black colour; but does not entirely deprive it of smell. Copper, tin, zinc, and phosphorus, quickly produce a black or gray powder, and deprive the solution of all smell and of the power of turning galls of a blue colour. This black powder, which consists of the osmium in a metallic state, and the oxide of the metal employed to precipitate it, may be dissolved in nitro-muriatic acid, and then becomes blue with infusion of galls.

If the pure oxide of osmium, dissolved in water, is shaken with mercury, it very soon loses its smell; and the metal, combining with the mercury, forms a perfect amalgam.

Much of the mercury may be separated by squeezing it through leather, which retains the amalgam of a firmer consistence. The remaining mercury being distilled off, a powder is left, of a dark gray or blue colour, which is the osmium in its pure state. By exposing it to heat with access of air, it evaporates, with the usual smell; but if the oxidation is carefully prevented, it does not seem in any degree volatile. Being subjected to a strong white heat, in a cavity made in a piece of charcoal, it was not melted, nor did it undergo any apparent alteration. Heated in a similar situation with copper and with gold, it melted with each of these metals, forming alloys which were quite malleable. These compounds were easily dissolved in nitro-muriatic acid, and, by distillation, afforded the oxide of osmium with the usual properties.

The pure metal which has been previously heated, does not seem to be acted on by acids; at least I could not perceive any effect produced by boiling it for some time with nitro-muriatic acid. By heating it in a silver cup with caustic alkali, it immediately combined with the alkali, and, with water, gave a yellow solution, similar to that from which it was procured. Acids expel from this solution the oxide of osmium, which has the usual smell, and the power of giving to infusion of galls the blue colour before mentioned.

XXX. *On a new Metal, found in crude Platina.* By William Hyde Wollaston, *M. D. F. R. S.**

Notwithstanding I was aware that M. Descotils had ascribed the red colour of certain precipitates and salts of platina, to the presence of a new metal; and although Mr. Tennant had obligingly communicated to me his discovery of the same substance, as well as of a second new metal, in the shining powder that remains undissolved from the ore of platina; yet I was led to suppose that the more soluble parts of this mineral might be deserving of further examination, as the fluid which remains after the precipitation of platina by sal ammoniac, presents appearances which I could not ascribe to either of those bodies, or to any other known substance.

My inquiries having terminated more successfully than I had expected, I design in the present Memoir to prove the existence, and to examine the properties, of another metal, hitherto unknown, which may not improperly be distinguished by the name of *rhodium*, from the rose-colour of a dilute solution of the salts containing it.

I shall also take the same opportunity of stating the result of various experiments, which have convinced me, that the metallic substance which was last year offered for sale by the name of palladium, is contained (though in very small proportion) in the ore of platina.

The colour of the solution that remains after the precipitation of platina, varies, not only according to its state of dilution, but also according to the strength and proportions of the nitric and muriatic acids employed. This colour, though principally owing to the quantity of iron contained in it, arises also in part from a small quantity of the ammoniaco-muriate of platina, that necessarily remains dissolved, and from other metals contained in still smaller proportions.

(A 1.) To recover the remaining platina, as well as to separate the other metals that are present from the iron, I have in some experiments employed zinc, in others iron, for their precipitation. The former appears preferable; but, when the latter has been used, the precipitate may immediately be freed from the iron that adheres to it, by muriatic acid, without the loss of any of those metals which are at present the subject of inquiry.

* From the *Transactions of the Royal Society of London* for 1804.

(A 2.)

(A 2.) Having in one instance dissolved such a precipitate in nitro-muriatic acid, and precipitated the platina by sal ammoniac, I suffered the remaining fluid to evaporate without heat; and obtained a mixture of various crystals, very different from each other in form and colour. From these, I selected for examination some that were of a deep red colour, partly in thin plates adhering to the sides of the vessel, and partly in the form of square prisms having a rectangular termination.

(A 3.) A portion of these crystals being heated in a small tube, yielded sal ammoniac by sublimation, and left a black residuum, which, by greater heat, acquired a brilliant metallic whiteness, but could not be fused under the blowpipe. Having obtained this substance from a distinctly crystallized salt, I was inclined to consider it as a simple metal; and, as I found it to be wholly insoluble in nitro-muriatic acid, I judged it not to be platina.

(A 4.) The crystals also, instead of being nearly insoluble, like the ammoniaco-muriate of platina, were dissolved in a small quantity of water, and gave a rose-coloured solution. Upon mixing this with a solution of platina, the ammonia was transferred by superior affinity to the latter, forming an ammoniaco-muriate of platina; and the precipitate was of a yellow colour. Consequently, the metal contained in the salt was neither platina, nor that which gives the red colour to the salts of platina.

It would be useless to detail my first unsuccessful experiments, made upon the properties of this metal, in hopes of discovering means by which its separation from platina might be effected; I shall therefore confine myself to the following process, which appears to be the most direct for procuring rhodium in a state of purity. In the same process also palladium is obtained, so as to afford a presumption, that it is rather a natural simple body than any artificial compound.

(B 1.) Since the platina to be procured in this country generally contains small scales of gold intermixed, as well as a portion of the mercury which the Spaniards employ for the separation of the gold, the platina used for my experiments, after being by mechanical means freed, as far as possible, from all visible impurities, was exposed to a red heat, for the purpose of expelling the mercury. It was then digested for some time in a small quantity of dilute nitro-muriatic acid, and frequently shaken, till the whole of the gold was dissolved, together with any impurities that might superficially adhere to the grains of platina.

(B 2.)

(B 2.) Of the ore thus prepared, nearly $2\frac{1}{2}$ ounces were then dissolved in nitro-muriatic acid, (diluted for the purpose of leaving as much as possible of the shining powder,) and the whole suffered to remain in a moderate sand heat, till completely saturated.

(B 3.) Such a portion of this solution was then taken for analysis, as corresponded to 1000 grains of the prepared ore. An ounce of sal ammoniac was next dissolved in hot water, and used for the precipitation of the platina. The precipitate obtained was of a yellow colour, and, upon being heated, yielded 815 grains of purified platina.

(B 4.) The water used for washing this precipitate having been added to the solution poured from it, a piece of clean zinc was immersed in it, and suffered to remain till there appeared to be no further action upon the zinc. The iron contained in the ore (to the amount of 14 or 15 per cent.) remained in solution. The other metals had subsided, in the form of a black powder, which I estimated between 40 and 50 grains; but, as there was no occasion to weigh it with accuracy, I thought it better not to dry this precipitate; for, if it be heated, the rhodium is in danger of being rendered insoluble.

(B 5.) As I had previously ascertained that this precipitate would contain platina, rhodium, the substance called palladium, copper, and lead, the two last metals were first dissolved in very dilute nitric acid, aided by a gentle heat. The remainder, after being washed, was digested in dilute nitro-muriatic acid, which dissolved the greater part, but left as much as $4\frac{1}{2}$ grains undissolved*.

(B 6.) To the solution were added 20 grains of common salt; and, when the whole had been evaporated to dryness with a very gentle heat, the residuum, which I had found from prior experiments, would consist of the soda-muriates of platina, of palladium, and of rhodium, was washed repeatedly with small quantities of alcohol, till it came off nearly colourless. There remained a triple salt of rhodium, which by these means is freed from all metallic impurities.

(C 1.) This salt, having been dissolved in a small quantity of hot water, and let to stand 12 hours, formed rhomboidal crystals, of which the acute angle was about 75°.

(C 2.) It was then again dissolved in water, and divided into two equal portions. Of these one was decomposed by a

* It was presumed that this residuum consisted principally of the metal called by Mr. Tennant iridium; but, as it was accidentally mislaid, and was not examined, it might also contain a portion of rhodium.

piece

piece of zinc, and the other examined by the following reagents.

(C 3.) Sal ammoniac occasioned no precipitation; but, when a solution of platina was added to the mixture, a precipitate was immediately formed, and the colour of this precipitate was yellow; which again proves, that the metal contained in this salt is neither platina itself, nor that which gives the red colour to its precipitates.

(C 4.) Prussiate of potash occasioned no precipitation, as it would have done if the solution had contained palladium.

(C 5.) Hydro-sulphuret of ammonia, which would have precipitated either platina or palladium, caused no precipitation of this metal.

(C 6.) The carbonates of potash, of soda, or of ammonia, occasioned no precipitation; but the pure alkalis precipitated a yellow oxide, soluble by excess of alkali, and also soluble in every acid that I have tried.

(D 1.) The solution of this oxide in muriatic acid, upon being evaporated, did not crystallize; the residuum was soluble in alcohol, and of a rose colour. Sal ammoniac, nitre, or common salt, caused no precipitation from the muriatic solution; but formed triple salts, which were not soluble in alcohol.

(D 2.) The solution in nitric acid also did not crystallize. A drop of this solution, being placed upon pure silver, occasioned no stain. On the surface of mercury a metallic film was precipitated, but did not appear to amalgamate. The metal was also precipitated by copper and other metals, as might be presumed, from the usual order of their affinities for acids.

(E 1.) The precipitate obtained by zinc (C 2.) from the remaining half of the salt, appeared in the form of a black powder, weighing, when thoroughly dried, nearly 2 grains, corresponding to about 4 grains in the 1000 of ore dissolved.

(E 2.) When exposed to heat, this powder continued black; with borax, it acquired a white metallic lustre, but appeared infusible by any degree of heat.

(E 3.) With arsenic, however, it is, like platina, rendered fusible; and, like palladium, it may also be fused by means of sulphur. The arsenic, or the sulphur, may be expelled from it by a continuance of the heat; but the metallic button obtained does not become malleable, as either of the preceding metals would be rendered by similar treatment.

(E 4.) It unites readily with all metals that have been tried,

tried, excepting mercury; and with gold or silver it forms very malleable alloys, that are not oxidated by a high degree of heat, but become incrusted with a black oxide when very slowly cooled.

(E 5.) When 4 parts of gold are united with 1 of rhodium, although the alloy may assume a rounded form under the blowpipe, yet it seems to be more in the state of an amalgam than in complete fusion.

(E 6.) When 6 parts of gold are alloyed with 1 of rhodium, the compound may be perfectly fused, but requires far more heat than fine gold. There is no circumstance in which rhodium differs more from platina, than in the colour of this alloy, which might be taken for fine gold, by any one who is not very much accustomed to discriminate the different qualities of gold. On the contrary, the colour of an alloy containing the same proportion of platina, differs but little from that of platina. This was originally observed by Dr. Lewis. "The colour was still so dull and pale, that the compound (5 to 1) could scarcely be judged by the eye to contain any gold*."

I find that palladium resembles platina, in this property of destroying the colour of a large quantity of gold. When 1 part of palladium is united to 6 of gold, the alloy is nearly white.

(E 7.) When I endeavoured to dissolve an alloy of silver or of gold with rhodium, the rhodium remained untouched by either nitric or nitro-muriatic acids; and, when rhodium had been fused with arsenic or with sulphur, or when merely heated by itself, it was reduced to the same state of insolubility. But when 1 part of rhodium had been fused with 3 parts of bismuth, of copper, or of lead, each of these alloys could be dissolved completely, in a mixture of 2 parts, by measure, of muriatic acid, with 1 of nitric. With the two former metals, the proportion of the acids to each other seemed not to be of so much consequence as with lead; but the lead appeared on another account preferable, as it was most easily separated, when reduced to an insoluble muriate by evaporation. The muriate of rhodium had then the same colour and properties, as when formed from the yellow oxide precipitated from the original salt, (D 1.)

(E 8.) The specific gravity of rhodium, as far as could be ascertained by trial on so small quantities, seemed to exceed 11. That of an alloy consisting of 1 part rhodium

* Lewis's Philosophical Commerce of Arts, p. 526.

and

and about 2 parts lead, was 11·3; which is so nearly that of lead itself, that each part of this compound may be considered as having about the same specific gravity.

F. As it was expected that the alcohol employed for washing the salt of rhodium (B 6.) would contain the soda-muriates of platina and of palladium, the platina was first precipitated by sal ammoniac. This precipitate was of a deep red colour; and, when it had been heated, to expel the sal ammoniac, the platina which remained was of a dark gray colour.

(G 1.) To the remaining solution, after it had been diluted to prevent any further precipitation of platina, I added prussiate of potash, which instantly occasioned a very copious precipitate, of a deep orange-colour at first, but changing afterwards to a dirty bottle-green, which I ascribed to iron contained in the prussiate.

(G 2.) This precipitate, when dry, weighed 12½ grains. After it had been heated, it left a metallic residuum, in small grains, of a gray colour, weighing nearly 7 grains. A small portion of it being heated with borax, communicated a dark brown colour to the borax, as from iron, and acquired a bright metallic lustre, but could not be fused under the blowpipe. With sulphur, however, it fused immediately into a round globule, which, by floating upon mercury, appeared of less specific gravity than that metal.

(G 3.) The whole quantity was then treated in the same manner, and purified by cupellation with borax, till it cooled with a bright surface. From the globule the sulphur was expelled, by exposure to the extremity of the flame; and it became spongy and malleable, weighing in this state very nearly 5 grains.

(G 4.) A portion of this metal was dissolved in strong nitrous acid, was precipitated by green sulphate of iron, and in other respects possessed all the properties ascribed to the palladium offered for sale, in the printed paper that accompanied it, as well as others since noticed by Mr. Chenevix.

(G 5.) In its precipitation by prussiates, it differs most essentially from platina; and consequently is by no means difficult to be distinguished, or separated from it.

(G 6.) The action of muriate of tin upon the solutions of these metals is also totally different. A dilute solution of platina, is thereby changed from a pale yellow to a transparent blood-red. A solution of palladium, on the contrary, usually becomes opaque, by the formation of a brown or black precipitate; but, if mixed in such proportion as to remain transparent, it changes to a beautiful emerald-green.

(G 7.)

(G 7.) In the formation of triple salts with the alkalis, as observed by Mr. Chenevix, palladium may be said to resemble platina; but the salts thus formed are far more soluble than the corresponding salts of platina, and differ entirely in the colour and form of the crystals.

(G 8.) The soda-muriate of palladium is a deliquescent salt; that of platina, on the contrary, forms permanent crystals.

(G 9.) The triple salts of platina, with either muriate of ammonia or of potash, form octaëdral crystals of a yellow colour, that are very sparingly soluble in water. The corresponding salts of palladium likewise resemble each other in every respect. The crystals are very soluble in water, but insoluble in alcohol; their form is that of a four-sided prism, and they each present a curious contrast of colour, that certainly is not observable in any known salt of platina.

(G 10.) Although the solution is of a deep red, the crystals are of a bright green when viewed transversely. In the direction of their axes, however, the colour is the same as that of the solution; but, on account of its extreme intensity, it is with difficulty distinguished in fragments that exceed $\frac{1}{100}$ of an inch in thickness. One consequence of this colour is nevertheless very observable; namely, that in viewing any crystal obliquely, it appears of a dull brown, that arises from a mixture of the red and green*.

The characters of palladium that have been enumerated, undoubtedly belong to none of the simple substances that we are acquainted with; and no experiment that I have made has tended to confirm the suspicion of its being a

* The change of colour above described, though certainly uncommon, is nevertheless not peculiar to the salts of palladium, but may be seen also in some kinds of tourmalin. Among those which come to us from Ceylon, some are transparent; and one variety is of a deep red in the direction of its axis, but of a yellowish green when viewed transversely. There is also a corresponding, but opposite contrast of colours, that has been observed by Müller, and described by Bergmann, in some of the Tyrolese tourmalins. The general aspect of these stones is black, and apparently opaque. Some, however, of which the fracture is vitreous, are found to transmit a yellowish-red light when viewed transversely, but in the direction of their axis the colour is a dull bottle-green.

In each of these tourmalins, as well as in the salts of palladium, the colour in the direction of the axis, is at least 10 times more intense than in the transverse direction. A thin lamina, cut from the end of a Tyrolese tourmalin for this purpose, transmitted no visible light, till it was reduced to 1-60th of an inch in thickness; and, when less than 1-100th of an inch, it was not more transparent than another portion of the same crystal seen transversely, 1-10th of an inch in thickness.

compound,

compound, consisting of any known ingredients. The experiments above related show evidently that the ore of platina contains a very small quantity of palladium; and it is not unlikely that this may have been a constituent part of some of the compounds obtained by Mr. Chenevix, and may have misled him, by some properties which he would consequently observe, into the supposition that he had formed palladium.

It is not, however, without having repeatedly endeavoured to imitate his experiments, that I have ventured to dissent from such authority. I made many attempts to unite pure platina with mercury, by solution and by amalgamation; but without success in any one instance.

From a solution of platina, carefully neutralized, as Mr. Chenevix directs, with red oxide of mercury, and mixed with a solution of green sulphate of iron, I indeed obtained such a precipitate of metallic flakes as he describes; but, upon examination of these flakes, they yielded mercury by distillation; and the remainder consisted of platina combined with a portion of iron, but had not any properties which I could suppose owing to the presence of palladium.

Upon comparing the specific gravity of this substance, which was said to be, at most, 11·8, with that of mercury or of platina, I was always strongly inclined to doubt the possibility of its being composed of these metals. I could recollect no one instance in which the specific gravity of any compound is less than that of its lightest ingredient, and could not, without careful examination, admit the supposition, that mercury could be rendered lighter by intimate union with platina. It now appears fully confirmed that this persuasion, arising from uniform experience, was well founded; for, if we consider the difficulty of producing even an imperfect imitation of palladium, the failure of all attempts to resolve it into any known metals, the facility of separating it from any mixed solution of those which it has been supposed to contain, as well as the number and distinctness of its characteristic properties, I think we must class it with those bodies which we have most reason to consider as simple metals.

XXXI. No.

XXXI. *Notices respecting New Books.*

The *Philosophical Transactions of the Royal Society of London for the Year* 1804, Part II., contain:—Analytical Experiments and Observations on Lac. By Charles Hatchett, Esq. F.R.S.—On the Integration of certain differential Expressions with which Problems in physical Astronomy are connected, &c. By Robert Woodhouse, A.M. F.R.S. Fellow of Caius College.—Observations on Basalt, and on the Transition from the vitreous to the stony Texture, which occurs in the gradual Refrigeration of melted Basalt; with some geological Remarks. In a Letter from Gregory Watt, Esq. to the Right Hon. Charles Greville, V.P. R.S. —An Analysis of the magnetical Pyrites; with Remarks on some of the other Sulphurets of Iron. By Charles Hatchett, Esq. F.R.S.—Remarks on the voluntary Expansion of the Skin of the Neck, in the Cobra de Capello, or hooded Snake of the East Indies. By Patrick Russell, M.D. F.R.S. With a Description of the Structure of the Parts which perform that Office. By Everard Home, Esq. F.R.S.—Continuation of an Account of the Changes that have happened in the relative Situation of double Stars. By William Herschel, LL.D. F.R.S.—Observations on the Change of some of the proximate Principles of Vegetables into Bitumen; with Analytical Experiments on a peculiar Substance which is found with the Bovey Coal. By Charles Hatchett, Esq. F.R.S.—On two Metals found in the black Powder remaining after the Solution of Platina. By Smithson Tennant, Esq. F.R.S.—On a new Metal found in crude Platina. By William Hyde Wollaston, M.D. F.R.S.

The *Transactions of the Linnean Society of London*, Vol. VII. contain: Charter of the Linnean Society of London.—Bye-laws of the Society.—Patent of Armorial Ensigns.—A new Arrangement of the Genus Aloë, with a chronological Sketch of the progressive Knowledge of that Genus, and of other succulent Genera. By Adrian Hardy Haworth, Esq. F.L.S. —On the Germination of the Seeds of Orchideæ. By Richard Anthony Salisbury, Esq. F.R.S. & L.S.—Account of the Tusseh and Arrindy Silk-Worms of Bengal. By William Roxburgh, M.D. F.L.S.—Description of the British Lizards; and of a new British Species of Viper. By Revett Sheppard, A.B. F.L.S.—Description of Bos Frontalis, a new Species, from India. By Aylmer Bourke Lambert, Esq. F.R.S. V.P.L.S.—Description of the Esox Saurus,

Saurus. By the Rev. Thomas Rackett, M.A. F.R.S. & L.S. —Description of several Marine Animals found on the South Coast of Devonshire. By George Montagu, Esq. F.L.S.—Descriptions of four new British Lichens. By Dawson Turner, Esq. M.A. F.L.S. Descriptions of some Species of Carex from North America. By Edward Rudge, Esq. F.L.S.—Remarks upon the Dillenian Herbarium. By Dawson Turner, Esq. F.R.S. A.S. & L.S.—Description of some Fossil Shells found in Hampshire. By William Pilkington, Esq. F.A.S. & L.S.—An Historical Account of Testaceological Writers. By William George Maton, M.D. F.R.S. & L.S. and the Rev. Thomas Rackett, M.A. F.R.S. & L.S.—An Illustration of the Grass called by Linnæus Cornucopiæ Alopecuroïdes. By James Edward Smith, M.D. F.R.S. P.L.S.—Description of such Species of Chironia as grow wild at the Cape of Good Hope. By Sir Charles Peter Thunberg, Knight of the Order of Wasa, Professor of Botany at Upsal, F.M.L.S.—Remarks on the Generic Characters of Mosses, and particularly of the Genus Mnium. By James Edward Smith, M.D. F.R.S. P.L.S.—Observations on the Zizania aquatica. By Aylmer Bourke Lambert, Esq. F.R.S. V.P.L.S.—Observations on the Durion, Durio zibethinus of Linnæus. By Mr. Charles König, F.L.S.—Observations on some Species of British Quadrupeds, Birds, and Fishes. By George Montagu, Esq. F.L.S.—Biographical Memoirs of several Norwich Botanists, in a Letter to Alexander MacLeay, Esq. Sec. L.S. By James Edward Smith, M.D. F.R.S. P.L.S.—Further Account of the Bos Frontalis. By Aylmer Bourke Lambert, Esq. F.R.S. V.P.L.S.—Description of a large Species of Rat, a Native of the East Indies. By Captain Thomas Hardwicke, F.L.S.—Extracts from the Minute-Book of the Linnean Society of London.—Catalogue of the Library of the Linnean Society, continued from page 394 of Vol. VI. of the Society's Transactions.—List of Donors to the Library of the Linnean Society.

XXXII. *Proceedings of Learned Societies.*

ROYAL INSTITUTION.

This national establishment opened its sessions on Tuesday the 13th of November. Mr. Davy will deliver twelve lectures on Chemical Analysis; Mr. Fletcher, a gentleman

whose talents have been long known among the literary conversazioni of the present day, twenty-four lectures on Natural Philosophy; Mr. Landseer, engraver to the king, three lectures on engraving; and Dr. Crotch six lectures on music.

Board of Agriculture.

Premiums offered by this Board.

[Continued from page 80.]

Culture of Hemp.—To the person who shall send to the Board, the best essay on the culture of hemp, which shall include the useful facts hitherto published, with such additions as the writer may be able to make, either from his own experiments, or those of others, within his knowledge, with the best means of extending the culture in the united kingdom, without lessening the growth of wheat—*thirty guineas.* Accounts to be produced on or before the first Tuesday in February, 1805.

Culture of Hemp.—To the person in his Majesty's colonies of Upper or Lower Canada, New Brunswick, and Halifax, who shall make the most satisfactory report to the Board, of the present state of the cultivation of hemp in those provinces, in respect of soil, previous state of the land, manure, seed, culture, watering, dressing, produce, price, and the expense of labour, with the state of population as applicable to this branch of culture; as well as of the obstacles to the extension of it, the best means of removing them, and of promoting the cultivation—*fifty guineas.* The report to be made on or before the first Tuesday in January 1806.

Weighing Machine.—To the person who shall, before the 25th of March 1805, produce to the Board, or shall erect in London, in some place to which the members of the Board can conveniently have access, the machine for weighing cattle alive, as high as 300 stone at 8lbs. and as low as five stones weight, that shall be the cheapest in proportion to its accuracy and utility—*twenty guineas.*

Machine for reaping corn.—To the person who shall invent, and produce to the Board, the best machine for reaping corn—*from one hundred to two hundred guineas, according to merit.*

Simplicity and cheapness of construction, and (if the application of horses or oxen be required) ease of draught, will be considered as essential objects. To be produced on or before the first Tuesday in May 1806.

Diseases

Diseases of Cattle.—To the person who shall write, and produce to the Board, the best practical essay, founded on experiments, on the diseases of neat cattle, their symptoms and cure—*the gold medal.* The essays to be produced on or before the first Tuesday in May 1806.

Diseases of Sheep.—To the person who shall write, and produce to the Board, the best practical essay, founded on experiments, on the diseases of sheep, their symptoms and cure—*the gold medal.* The essays to be produced on or before the first Tuesday in May 1806.

Diseases of Swine.—To the person who shall write, and produce to the Board, the best practical essay, founded on experiments, on the diseases of swine, their symptoms and cure—*ten guineas.* The essays to be produced on or before the first Tuesday in May 1806.

XXXIII. *Intelligence and Miscellaneous Articles.*

HERCULANEUM MANUSCRIPTS.

The literary world will rejoice to learn, that the six volumes of Papyri, presented to the prince of Wales by the king of Naples, are arrived in London; and thus, under the immediate auspices of his royal highness, the learned and the ingenious will be invited to exert their skill in endeavouring, not merely to develop their contents, but to contrive some more speedy and efficacious means than have been hitherto practised, for unrolling and transcribing the many volumes that yet lie in the ashes of Herculaneum and Pompeii. It is a most important event to the cause of literature, that the prince has patronized this undertaking with so much ardour and liberality, since in no other country could the resources of science and art be so well applied to the object as in England. Our artists will vie with one another in the suggestion of means to facilitate the decyphering of the nearly obliterated manuscripts; and if some happy contrivance should be found to preserve the tinder from perishing until it can be traced and read, what treasures of literature may not yet be brought to light, and what honours and gratitude will not be due to his royal highness for his noble patronage of the design!

Our readers may wish to have a short statement of the circumstances that induced the prince to take steps to further this great work. In the year 1800 he directed the rev. John Hayter, a gentleman eminently qualified for the task, to

to go to Italy, and, with a suitable provision, to exert himself on the spot, under the kind permission of the king of Naples, to unrol and transcribe the papyri. He was generously moved to this undertaking by the love of literature, and by the accounts of the very slow progress which up to that time had been made in the work of developing the manuscripts.

The importance of the undertaking will be best shown to our readers by an extract from the letter which Mr. Hayter addressed to the prince at the outset of his mission in 1800, a few copies of which were printed at the time, and distributed among literary men.

After a very becoming expression of gratitude to his royal highness for the honour of his confidence, he gives this short narrative:

"The numerous settlements of the Greeks in Italy received the name of Magna Græcia, because their mother country was of a size considerably less than that in which they were planted: among these were nearly all the cities in the province of Campania, including Naples, the capital of his Sicilian majesty, and also Herculaneum and Pompeii, which are supposed to boast a foundation coeval with Hercules himself, three thousand and fifty years ago, or twelve hundred and fifty years before the Christian æra. This province, more than any other part of Magna Græcia, was always celebrated for the studious and successful cultivation of the arts and sciences. The two cities of Herculaneum and Pompeii ranked next to that of Naples in every respect, as places of considerable note; they had their public theatres, with every other attendant of great population, splendour, opulence, and general prosperity. These, in common with all the rest of Campania, became the elegant and favourite resort of the Romans, for the different purposes of health, luxury, repose, and erudition.

"In the ninth year of Nero's reign*, these two cities experienced a most formidable shock from an earthquake, which overthrew a great part of them. Nor had they recovered altogether from the effects of this calamity by their own exertions, and the aid of imperial munificence, when a second calamity, of a different nature, but equally unexpected, consigned them both at once to the most com-

* U. C. 816.
A. D. 63.
Caius Memmius Regulus, } Consuls.
Lucius Virginius Rufus, }

plete

plete oblivion. This calamity was the great eruption of Vesuvius, which happened on the 24th day of August*, two full months from the accession of the emperor Titus Vespasian. Herculaneum was buried under a mass of lava, and volcanic matter, to the depth of twenty-four feet. Pompeii, being more distant from the mountain, was overwhelmed principally with a shower of ashes, nor in any place more than half the depth of the other city. But the fate of both was sudden and inevitable; and yet it appears that almost all of the inhabitants, and, what is an equally surprising circumstance, more of the Herculaneans than the Pompeians, escaped. By the few skeletons which have been found in either place, the relation of Dio Cassius, who states the destruction of the people while assembled at the theatre, is proved to be totally erroneous. It may be proper to remark, that before this eruption the whole of Vesuvius was in a state of cultivation and fertility, from the top to the bottom; and though the form and soil of the mountain in one particular spot seemed to denote the traces of some former explosion, yet no extant memorial of any kind had recorded it.

"Neither of these two cities was discovered again till a long period of sixteen hundred and thirty-four years had elapsed. It was in the year 1713, that some labourers, in sinking a well, struck their tools against a statue, which was on a bench in the theatre of Herculaneum. Forty years afterwards Pompeii was excavated with much less difficulty, as the incumbent stratum was neither so hard nor so deep as that of the former city.

"The number of the manuscripts saved from both those cities is said to be about five hundred; but, if I am rightly informed by those whose official situation must give them a competent knowledge of the subject, your royal highness, by facilitating the development of these volumes, will probably be the means of further excavation, and of rescuing from their interment an infinite quantity of others. About thirty years ago, his Sicilian majesty ordered the development, the transcription, and the printing of the volumes which had then been saved, to be undertaken. This operation was accordingly begun, and has never been discontinued till the late invasion of the French. But its mode, however excellent, was extremely slow; it has been per-

* U. C. 832.
A. D. 79.
Flavius Vespasianus 9 } Consuls.
Titus Vespasianus 8 }

formed by a single person, with a single frame only, under the direction of the marquis del Vasto, chamberlain to the king, and president of the royal academy.

"The frame consists of several taper and oblong pieces of wood, with parallel threads of silk that run on each side, the length of each piece: when the frame is laid on any volume, each piece of wood must be fixed precisely over each line of the page, while the respective threads being worked beneath each line, and assisted by the corresponding piece of wood above, raise the line upwards, and disclose the characters to view*.

"The operation seems ingenious, and well adapted to the purpose: it was, I believe, invented by a capuchin at Naples. The fruits of it are said to be two publications only; one on music, by the celebrated Philodemus, who was a cotemporary of Cicero; and the other on cookery. The first is in his majesty's library, at the queen's palace. Through the obliging politeness of Mr. Barnard, the king's librarian, I have had the advantage of perusing it. Indeed, I hope your royal highness will not disapprove my acknowledging in this place the very warm and respectful interest which both this gentleman and the right honourable the president † of the Royal Society have expressed for the furtherance of your royal highness's great and good design. Meanwhile, by this specimen of Philodemus, I am convinced that, if the frames should be multiplied to the proposed extent, several pages of thirty different manuscripts might be disclosed and transcribed within the space of one week.

"But the very period at which the manuscripts were buried, serves to point out to your royal highness that you may expect the recovery of either the whole, or at least parts, of the best writers in antiquity, hitherto deemed irrecoverable. All of these, in truth, had written before that

* From the want of information in this country, I am apprehensive that this description of the frame is rather defective. But, when I am on the spot, I shall not fail to transmit, for your royal highness's inspection, an exact model of its mechanism. I am equally apprehensive that the same cause may have occasioned more errors in this part of my account: the same local advantage, of which I shall be careful to make the earliest use, will enable me to remove them.

† It was suggested by Sir Joseph Banks, that, from the nature of the antient atramentum, which perhaps was not so much an ink as a paint, and from the material of these manuscripts, there may be derived a chance of applying a chemical process to this development of the cinders with increased expedition and effect. The suggestion is of the first importance: hereafter there may be an opportunity of ascertaining its utility by experiment.

period, if we except Tacitus, whose inestimable works were unfortunately not composed till twenty years afterwards, during the reign of Trajan.

"Nor can it be imagined for a moment, that among five or six hundred manuscripts, already excavated, and especially from the numberless ones which further excavations may supply, lost at such a period in two of the most capital cities, in the richest, most frequented, and most learned province in Italy, each of them an established seat of the arts and sciences, each of them the resort of the most distinguished Romans, not any part of those illustrious authors should be discovered.

"But the manuscript of Philodemus itself makes the reverse of such an idea appear much more probable. To the moderns, who have

> "Untwisted all the chains that tie
> The hidden soul of harmony,"

his Treatise on Music cannot, indeed, be supposed to communicate much information; yet the subject is scientific, and scientifically treated. The author himself, too, was one of the most eminent men in his time for wit, learning, and philosophy. But in the rest of the arts * and sciences, in history, in poetry, the discovery of any lost writer, either in whole or part, would be deemed a most valuable acquisition and treasure, and form a new æra in literature.

"It is extremely fortunate that the characters † of these manuscripts, whether they should be Greek or Latin, must be very obvious and legible. Before the year of our Lord 79, and some time after it, the Majusculæ or Unciales Litteræ, capital letters, were solely used. A page, therefore, in one of these manuscripts, would present to your royal highness an exact image of some mutilated inscription in those languages on an antient column, statue, or sepulchre.

"There cannot remain a doubt, even omitting the assurances from men of official situation to that effect, that your royal highness's superintendant will receive every possible assistance from the marquis del Vasto; and in that case it seems improbable that the object of this mission can be altogether fruitless.

"With such a termination of it, however, your royal

* Particularly the antient mode of cementing in architecture, and on proportions in sculpture and painting.

† One of the principal difficulties in copying these manuscripts appears to consist in supplying the proper letters or words at the different chasms.

highness, by having proposed to concur with his Sicilian majesty in the quicker and more effectual development, transcription, and publication of these manuscripts, will reap the satisfaction of having made a most princely attempt in behalf of knowledge and literature, on an occasion where their interests might be affected most materially, and in a manner of which no annals have afforded, or can hereafter afford, an example. Your very interposition will be your glory: your want of success will only make the learned world feel with gratitude what you would have done."

The interposition of his royal highness has had the happiest effect. The splendid encouragement which he gave to the work revived the drooping spirits of the Italian literati; and the consequence has been, that the business of unrolling and transcribing the manuscripts now proceeds with an alacrity which promises the most brilliant success. In forty-six years not more than eighteen rolls were developed before the interference of our prince. Under his encouragement, ninety have been recovered in two years! What new facilities may not now be expected when all the vigour of British intelligence is exerted on the subject!

EARTHQUAKES.

Clermont Ferrand, Oct. 24, 1804.

At half past eight in the morning, on the 25th of August last, the weather being very serene, the thermal waters of Nery (Allier) suddenly became agitated in a wonderful manner. At the principal place from which they issue they first rose to the height of a foot above the level of the bason which contains them, then to three, and in that state exhibited for two minutes the figure of a cone the base of which seemed to be four or five feet in circumference. A great agitation was observed in other parts of the bason. The water boiled with the greatest violence: a greater quantity of gas seemed to escape; and this extraordinary effervescence continued for the space of five or six minutes.

Letters from Almeria, in Spain, announce, that at half after eight, on the 25th of August, three shocks of an earthquake were felt in that city: they were so violent that not a house escaped suffering injury: some of the houses were destroyed. Is it not probable that there might be some connection between this earthquake and the phænomenon observed at Nery? May not the perfect coincidence of these two events, which took place the same day, and at the same hour, throw some light on the cause, still unknown, of the heat

heat of thermal waters? These questions must be submitted to chemists and philosophers.

We must add, that at the time of the earthquake at Lisbon, in 1755, the same waters experienced so much agitation that they rose in considerable quantity above the sides of the bason. M. de Vauvret, mayor of Nery, attests this fact, having been an eye-witness of it. At the time of the same earthquake at Lisbon the thermal waters of Bourbon l'Archambault suddenly increased in a similar manner. We do not know what took place at them on the 25th of August last. The public journals mention, that on the same day some very strong shocks of an earthquake were experienced in Holland. The same day Vesuvius gave some new signs of an approaching eruption.

NEWLY DISCOVERED ISLAND.

This island was discovered in the South Sea by captain Sowle, in the American ship Palmyra, of Providence, Rhode Island, on the 10th of November 1802. As the weather was fine, that day at noon he had an observation of the sun's altitude, by which the latitude is accurately ascertained; and as he took his departure from Christmas Island, and had a gentle westerly wind, it is scarcely possible there can be any error in the longitude.

This island lies out of the track of most navigators who pass either from America to Asia, or from Asia to America; and till lately English whalers have been prohibited fishing in that quarter; which accounts for its not having been seen before. It is probable that there are several other islands in the same direction. Captain Sowle thinks he passed one the day before, as he saw many birds, and believed he heard breakers; but the weather being very hazy he could not see either rocks or land.

Palmyra Island, so called after the name of the vessel, is situated in north latitude 5° 49′, and in west longitude 162° 23′, from London. It is about three leagues in extent. There are two lagoons on it, in the westernmost of which is twenty fathom water, with a fine sandy bottom. It is very dangerous to approach the western part of the island, on account of the coral rocks which are just below the surface of the water, and extend to the distance of three or four leagues from the shore.

The eastern part terminates in a steep reef of coral, over which the sea breaks with considerable force.

On the north-west side there is good anchoring ground, about

about three quarters of a mile from the breakers, in eighteen fathom water, on a coral bottom.

There is no inhabitant on the island; nor was any fresh water found; but cocoa nuts of very large size are in great abundance; and fish of various kinds, and in great shoals, surround the island.

A great quantity of drift wood lay on the beach, which enabled those who landed to ascertain that the rise of the tide was about eighteen inches.

ŒCONOMY OF LIGHT.

We announced some time ago that Mr. Paul, of Geneva, had effected a considerable improvement in lamps for streets. We understand that his invention has since been extended to lamps for domestic purposes, possessing the property of effecting the perfect combustion of common lamp oil, which costs only about the half of spermaceti oil, and yielding a cheerful, steady, and durable light, without smoke or smell.

INFORMATION TO MARINERS.

The following article was furnished by captain Candler, who arrived at Boston on the 8th of August in the schooner Betsey, from Madeira:

"On the 29th of May I was running for the western islands, when I made something which appeared like a sail, but, as I approached it nearer, discovered it to be a rock, the top of which was nearly 100 feet out of water, and, from appearance, deep water all round about it. It blowing very hard, I was not able to sound, or examine the rock any further than by running within a cable's length of it on the northern side. By observation I found it lay in lat. 39° 47′ north, and, by calculation, in long. 34° 29′ west. The situation of this stupendous rock may be relied on, as I was very particular in my course and distance till I made the land, which was the third day after: I then made Fayal. As I never saw a rock laid down in this situation, I think it my duty to give this information to the public.

(Signed) JOHN CANDLER."

VOLCANOES.

Letters from Petersburgh, of the 20th October, mention, that near the southern angle of the fortress of Fanagorji, a hill on the summit of a mountain, situated contiguous to a lake of 300 fathoms in circuit, began to swell on the 4th of July last, between twelve and one o'clock at night. The hill rose about twelve fathoms, and then burst, with lightning

ning and a rumbling noise like thunder, emitting burning clods and ignited stones, which were thrown a considerable height, and to a distance of 100 fathoms. Next a clear flame made its appearance, which spread a disagreeable smell, and blazed for an hour and a half. The eruption occupied one half of the lake, forming a hill of ten fathoms in height, and 300 in circumference.

Rome, Oct. 29.

The eruptions of Mount Vesuvius have ceased. The following fact may deserve the attention of naturalists :—The English ship of the line which lies before Naples, changing its position during the time of an eruption, one of the anchors, when drawn up, was found to be so hot that the sailors could scarcely touch it. Does not this prove that the principal source of the volcano is under the sea?

VACCINATION.

Dr. Valentin, of Paris, is said to have adopted the following method of inoculating the cow-pock :—He collects a quantity of the dried vaccine pustules or incrustations, which he reduces to powder, and forms into a kind of paste with water. With this substance he inoculates his subjects, by means of a lancet, in the usual way. W. B.

LONGEVITY.

Lately died at Gloves, near Athenry, Ireland, of a short illness, Mr. Denis Coorobee, of Ballindangen, aged 117, a truly honest man. He retained his faculties to the last, and, until two days previous to his death, he never remembered to have any complaint or sickness whatever (toothache only excepted). Three weeks before his death he walked from his house to Galway, and back the same day, which is 26 miles. He could, to the last, read the smallest print without the assistance of glasses, which he never accustomed himself to, with as much ease as a boy of sixteen. He was a man of strong natural powers; and, as he followed husbandry, the results of his long experience, as might naturally be expected, were highly useful in improving agriculture. It is upwards of seventy years since he propagated that most useful article the black potatoe.

He was married seven times: the last time when he was ninety-three years of age. By his different wives he had 48 children. His descendants by these were 236 grand children, 944 great grand children; and 25 great great grand children, the oldest of whom is four years of age. His youngest son by his last marriage is now about eighteen years old,

SUBSTITUTE

SUBSTITUTE FOR CINCHONA AND FOR WHEAT.

M. Westring, of Norkoping, in Sweden, in a letter to M. Bergman, at Paris, says: "Tell M. Vauquelin that I have found that the inner bark of the *Pinus sylvestris* acts in the same manner as yellow quinquina (*cinchona regia*), and that for two years I have made use of the powder of this bark with the same advantage as quinquina; and that, in certain cases it is even of superior utility.

"M. Tutin announces, that in some provinces of the north of Sweden the poor inhabitants form with the *sphaganum palustre* a kind of bread, which is white, and of the same quality as wheaten bread. M. Tutin has analysed it, and found that this vegetable substance contains a great quantity of saccharine matter;—a proof that nature has given us the means of supplying the place of wheat in times of scarcity."

ASTRONOMY.

A table of the right ascensions and declinations of Pallas and Ceres for November and December 1804.

	Pallas.					Ceres.			
	Right Ascen.			Decl. South		Right Ascen.		Decl. South.	
Nov. 2	21h	51m	40s	6°	45′	13m	48s	13°	32′
5	..	52	40	7	4	12	32	13	25
8	..	53	48	7	23	11	28	13	16
11	..	55	8	7	40	10	36	13	5
14	..	56	40	7	55	9	56	12	53
17	..	58	20	8	9	9	32	12	40
20	22	0	8	8	21	9	16	12	25
23	..	2	4	8	32	9	16	12	9
26	..	4	16	8	42	9	24	11	52
29	..	6	24	8	50	9	48	11	33
Dec. 2	..	8	44	8	57	10	20	11	13
5	..	11	12	9	3	11	8	10	53
8	..	13	48	9	7	12	4	10	31
11	..	16	32	9	11	13	12	10	9
14	..	19	20	9	13	14	32	9	45
17	..	22	2	9	14	16	0	9	21
20	..	25	12	9	14	17	36	8	56
23	..	28	20	9	14	19	24	8	31
26	..	31	32	9	11	21	20	8	5
29	..	34	48	9	9	23	24	7	38

SMEARING OF SHEEP.

The following has been found effectual:—Immediately after the sheep are shorn, soak the roots of the wool that remains all over with oil or butter and brimstone, and three or four days afterwards wash them with salt and water: the wool of next season will not only be much finer, but the quantity will be in greater abundanee. It may be depended upon that the sheep will not be troubled with the scab or vermin in that year. Tar water is a safe and effectual remedy against maggots.

IMPROVEMENT OF MOSSY LANDS.

Sir John Sinclair has eommunicated to the public the result of some extensive experiments he has been lately making on the improvement of mossy lands.

He states his failure for two years; but the third had completely removed all doubts of his ultimate sueeess in this important undertaking.

The causes of his original failure, and of his ultimate sueeess, he assigns to his having, at first, omitted to mark the distinetion between quiek and dead moss, which was latterly called to his attention by a perusal of Dr. Anderson's Practical Essay on Peat Moss; in which, for the first time to his knowledge, that distinction is pointed out. "While it is quick or growing, it cannot afford food for other vegetables, being a vegetable, or a combination of vegetables, itself; it is necessary, therefore, to convert it into dead moss, before it can be productive." And he assigns this additional cause, that he had adopted the mode used in England for flat fens, whereas the grounds on which he tried the experiments lay on the sides of hills.

The mode he recommends is, after having used the fen plough for paring the surface merely, for which alone it is caleulated, to plough deep before attempting to crop the land, the utility of whieh praetice Dr. Anderson had experienced. "He knew," says Sir John, "the beneficial effects of deep ploughing, and of exposing moss to the influenee of frost, by whieh it is eonverted not only into a fertile soil, but even into a manure well adapted for light or clayey lands. It is, however, partieularly to be observed, that exposing a mossy soil to the influence of the sun, or ploughing it during the summer season, does mischief, drying up its moisture, and changing it into peat for fuel, after which it is almost proof against the effects of frost; whereas the more it can be exposed to frost the better; as it is thus changed

changed from quick into dead moss, and fertilised at the same time. Hence it appears that the mosses which are so gloomy and so unpleasant to look at, in their original state, and the abundance of frost, which so many object to in the climate of Scotland, may become sources of fertility and riches."

Preparation.—On this head he recommends to begin with draining the land, so as to put it into a state for being ploughed, without rendering it at the same time too dry. After burning the heather, and using the fen ploughs for paring the surface, the surface may be made into turf walls for sheltering the grounds, or for filling up hollows. When the surface is cleared, the moss to be ploughed, to the depth of from six to nine inches, with a common Scots plough, during the months of September, October, and all the winter months while practicable, exposing the moss as much as possible to the frost. The frequent use of a heavy roller is recommended, as rendering the soil sooner capable of producing abundant crops, and effectually banishing that noxious weed sorrel, with which it is otherwise apt to overspread.

As manure—fire spread over the surface is recommended; the ashes to be immediately harrowed in, and the ground sown. Dung, lime, clay, sand, or small gravel, may also be employed, as circumstances require.

Bear, oats, rye, rye-grass, rape, red clover, and the grass called Yorkshire fog, seem the crops which answer best.

Of the succession of crops sufficient time has not elapsed to enable a judgment to be formed. The great object, however, is stated to be, to get the lands laid down into grass as speedily as possible. They can then be broken up with the fen plough, the surface burnt, and the quantity of rich ashes which the roots of the grass will produce, will ensure a succession of abundant crops for the last three years, of which two may be grain, and with the last crop of grain the land may be again laid down in grass.

"There is great reason," says Sir John, "to believe, that, by following such a system, the extensive bogs in England, Scotland, and Ireland, may be rendered fertile, and a great addition made to the wealth of the country, and to the subsistence of its inhabitants."

LIST OF PATENTS FOR NEW INVENTIONS

Which have passed the Signet Office from October 24 to November 24, 1804.

To William Henry Clayfield, of the city of Bristol, wine-merchant,

merchant, for certain processes for separating the alkalis of pot-ash and of soda from their sulphates, or vitriolic salts; and from their sulphurets, or combinations with sulphur; as in soaper's slack ash, and other similar compounds.

To Robert Raines the younger, of the town and port of Hull, in the county of York, tanner and glue-manufacturer, for a method for the making and manufacturing of hard glue, from the tail, fins, and other parts of the whale fish.

To James Sharples, of the city of Bath, in the county of Somerset, esq., for certain combinations and arrangements of implements and mechanical powers, and certain principles and forms of tables useful for surveying, and various other purposes.

To James Ryan, of Doonane, in the Queen's County, Ireland, engineer to the undertakers of the Grand Canal, for his invention of sundry tools, implements, or apparatus, for boring the earth for coal, and all kinds of minerals and subterraneous substances, by which the different strata may be cut out in a cheap and expeditious manner, in cores or cylinders, from 1 inch to 20 inches and upwards in length, and from 2 inches to 20 inches and upwards in diameter, so as to be taken up entire at any depth that has hitherto been bored; by which not only the quality of such minerals and substances, but also the declination or dip of the strata, can be ascertained beyond a possibility of mistake; and which tools, implements, or apparatus, are also applicable to the purposes of sinking for wells, and giving vent to subterraneous water in bogs, and draining mines and grounds, and ventilating pits, and other beneficial purposes.

To John Edwards, of Bow-street, in the parish of St. Paul, Covent Garden, in the county of Middlesex, currier and harness-maker, for certain improvements in fire-places; calculated to save fuel, give a more general heat, and prevent chimneys from smoking.

To Matthew Gregson, of Liverpool, upholder, for a method of cleansing feathers for beds; and hair, wool, down, and other the natural covering of birds and animals, from their animal oil, in the most perfect manner, and in such a way as to render them more healthful, sweet, and pleasant for use.

To Edward Steers, of the Inner Temple, London, esq., for an engine producing a force by the impetus which the parts of a fluid body have to an equal altitude, applicable to the working all kinds of machinery.

METEOROLOGICAL

METEOROLOGICAL TABLE

BY MR. CAREY, OF THE STRAND,

For November 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Oct. 27	49°	54°	44°	29·78	12°	Rain
28	46	53	49	·66	10	Fair
29	49	52	48	·56	5	Rain
30	47	55	50	·21	16	Fair, with rain at night
31	49	58	51	·46	18	Fair
Nov. 1	52	59	51	·60	29	Fair
2	50	53	47	·81	10	Showery
3	45	46	42	30·25	26	Fair, with wind
4	42	44	41	·06	20	Fair, with wind
5	39	43	40	29·90	20	Cloudy
6	39	40	37	·95	20	Cloudy
7	37	45	45	·75	15	Cloudy
8	47	52	47	·42	5	Cloudy
9	46	51	50	·42	4	Foggy
10	50	54	51	·20	0	Rain
11	50	50	45	·35	0	Rain
12	47	55	57	·93	15	Fair
13	52	57	52	·67	5	Rain
14	50	53	49	·52	12	Stormy
15	45	46	45	·86	7	Cloudy
16	45	47	46	30·00	6	Small rain
17	44	47	45	·11	15	Fair
18	45	52	47	·15	10	Cloudy
19	50	52	46	·01	0	Rain
20	44	50	48	·04	12	Fair
21	46	50	42	29·74	32	Fair
22	42	47	37	·85	33	Fair
23	39	48	46	·82	10	Rain
24	35	34	36	·80	0	Snow and rain
25	40	43	35	·85	25	Cloudy
26	34	43	34	30·06	19	Fair

XXXIV. *Concerning the Analytical and Synthetical Modes of Reasoning made use of in Mathematics and other Sciences.* *By the Rev.* JOHN TOPLIS, *A. M.*

To Mr. Tilloch.

SIR,

If you think the following worth insertion in the Philosophical Magazine, it is at your service. I have almost wholly extracted it from a long discourse read before the Philomatic Society at Paris by S. F. Lacroix. I am, sir,

Your sincere well-wisher,

JOHN TOPLIS.

Arnold, Notts,
October 25, 1804.

There are two methods of reasoning made use of in the mathematical sciences; the synthetical and the analytical. By referring back to the Greek origin of the words synthesis and analysis, we shall find that one signifies composition, and the other resolution or decomposition. Nothing appears clearer at the first glance than these denominations; and we easily conceive that the methods they denote are the inverse one of the other: nevertheless, it appears to me that we do not pay sufficient attention to the difference between the proceedings of synthesis and analysis, nor form always distinct notions of them. I therefore thought it necessary to search into the writings of the antients for examples of composition and resolution, in order to fix my ideas upon this important point; from which the following reflections have arisen:

The Elements of Euclid are according to the synthetical method. That author having formed certain axioms, and made certain demands, advances his propositions, which he proves by means of what precedes; and thus continually passes from simple to composite, which is an essential character of synthesis.

At the origin of geometry we meet with traces of the analytical method; for it is not correct to suppose that algebra constitutes exclusively analysis: it serves likewise to facilitate synthetical demonstrations; for it is at the bottom only an abridged and regular method of writing, by means of which we represent all the relations which magnitudes can have with each other: and I shall remark upon this subject, that Condillac, when he shows in his Logic that algebra is a language, merely repeats what Clairaut asserted and proved in his *Elémens d'Algèbre*, printed in the year 1748.

The first usage of analysis in geometrical researches is attributed

attributed to Plato. By this method we suppose the proposed problem is already resolved; from which it results that one condition is fulfilled, or, what comes to the same, that an equality takes place amongst certain magnitudes given and others sought. It is by finding out the consequences of the condition which we suppose fulfilled, or of the equality which is the consequence of it, that in the end we discover the unknown quantity, or trace the proceeding which it is necessary to follow in order to perform what is demanded.

I cannot do better than show here the definitions which Vieta has given of synthesis and analysis, after Theon, a geometrician of Alexandria, who, from his living so much nearer the times of the antients, was better able to judge of their opinions than we are.

"Est veritatis inquirendæ via quædam in mathematicis, quam Plato primus invenisse dicitur, a Theone nominata analysis, et ab eodem definita, adsumptio quæsiti tamquam concessi per consequentia ad verum concessum. Ut contra synthesis, adsumptio concessi per consequentia ad quæsiti finem et comprehensionem." (*Vietæ opera*, pag. 1.)*

The

* There is likewise a definition of analysis and synthesis given in the preface to the seventh book of the Mathematical Collections of Pappus, which, for its curiosity, I shall insert.

Analysis is the way which, proceeding from the thing demanded, arrives, by means of certain established consequences, to somewhat known before, or placed among the number of principles acknowledged for true. This method makes us go from a truth or proposition through all its antecedents; and we call it analysis, or resolution, or an inverted solution. In synthesis, on the contrary, we begin from the proposition last found in analysis, ordering properly the above antecedents, which now present themselves as consequents; and by combining them amongst themselves we arrive at the conclusion sought, from which we proceeded in the first case.

We distinguish two sorts of analysis:—in one, which may be named contemplative, it is proposed to discover the truth or falsity of an advanced proposition; the other is related to the solution of problems, or the research of unknown truths. In the first, by assuming for true, or as formerly known, the subject of the advanced proposition, we proceed by the consequences of the hypothesis to something known; and if the result is true, the proposition advanced is likewise true. The direct demonstration is lastly found by taking, in an inverse order, the different parts of the analysis; if the consequence to which we arrive at last is found to be false, we conclude that the proposition analysed is likewise false. When have to prove a problem, we suppose it already known, and we proceed upon this supposition till we arrive at something known. If the last result which we can obtain is comprised in the number of what geometricians call known truths, the question proposed can be resolved. The demonstration (or properly the construction) is again formed, by taking, in an

inverse

The demonstration of theorems in the manner called reductio ad absurdum is, properly speaking, an analytical proceeding; for we suppose the converse of the proposition is true, and by seeking consequences which are absurd make it appear that the hypothesis is so likewise.

I believe the characteristics of synthesis and analysis in the mathematics are rendered tolerably clear by the preceding descriptions. In the first method, the proposition enunciated is always the last consequence of the chain of reasonings which form the demonstration: it is a composition; for we add principle continually to principle, until we come to this consequence.

In analysis, on the contrary, by supposing the question resolved, we take in the whole of the subject; and making it pass with different forms, or making diverse traductions of the enunciations, we come to the solutions sought.

Condillac, in the fourth volume of his Course of Studies, makes it appear that all the art of reasoning merely consists in discovering the identity of diverse propositions; it is the order in which we connect the propositions that constitutes the method: moreover, when we reason synthetically, all the propositions that we make use of are identic until the last, which is itself a consequence of the preceding ones; and, by containing the subject of the enunciation, shows that the proposition advanced is true. When we reason analytically, we proceed from the enunciation, which is not identic by itself; and all the traductions which we pass by are merely hypothetical, until we arrive at the last, which always ought to render it identic; and from that results the determination of the quantity sought: likewise by the connection of the anterior ideas all the intermediate propositions become identic, and consequently the proposed question is resolved.

Those who understand algebra will readily perceive that I have traced the order made use of in resolving equations; they will see that at the last operation, when we have obtained the value of the unknown quantity, the final equation will become identic by its substitution; which will also be the case with all those which precede it.

Analysis is in general the method of invention; and we

inverse order, the different parts of the analysis. The impossibility of the last result of the analysis will prove evidently, in this case as in the preceding one, that of the thing demanded.

There is likewise, in the solution of every problem, what is called the determination; that is to say, the reasoning by which we show when, in what manner, and how many different ways, the problem can be solved.

believe that through its means the geometers of the two last centuries found out the numerous discoveries which made them so illustrious, and which have served as a foundation for the labours of their successors. But either to conceal their proceedings, or probably not being sufficiently used to the method, they dared not entirely trust to it; but when they had discovered a proposition, they always demonstrated it synthetically. It appears from the posthumous works of Pascal and Roberval, that they first made use of the method of indivisibles to resolve problems, and afterwards demonstrated them according to the manner of the antients. They generally concealed the proceedings which they made use of; because, their ways of invention not being reduced to general rules and methods, they had the greatest interest in keeping them secret, for to assure themselves of arms proper to make them superior in the attacks which their rivals made by their defiances, which increased every day*.

Certain authors, in very different sciences, supposing that the evidence of which geometry exclusively boasted was owing to the method of geometers, thought, by applying this method to the object of their researches, they should be enabled to protect it from opposition; but it is easy to perceive that this imitation of method is imperfect, and that there will also be some difference owing to the nature of the subject.

It is in chemistry that the application of the two methods appears most evident, and conformable to the etymology of their names. We combine together certain simple substances, or regarded as such, and thus operate by synthesis. We take a compound body, and separate it into its component

* This could not be Newton's motive; for he appears to have supposed that a mathematical proposition was not fit to be published but with a synthetical demonstration. In his Treatise upon Fluxions, he expresses himself as follows upon this subject:

"Postquam area curvæ alicujus ita (analyticè) reperta est et constructa, indaganda est demonstratio constructionis, ut omisso, quatenus fieri potest, calculo algebraico, theorema fiat concinnum et elegans, AC LUMEN PUBLICUM SUSTINERE VALEAT."

Laplace thinks likewise that Newton "had discovered by analysis the greatest part of his theorems; but his predilection for synthesis, and great estimation for the geometry of the antients, induced him to give a synthetical form to his theorems, and likewise his method of fluxions." (*Exposit. du Syst. du Monde*, 2d edit. p. 335.)

We find in the luminous reflections upon the character and respective advantages of synthesis and analysis which follow this quotation, all that precision and clearness which the author has made use of in the rest of his excellent work, upon the most abstract principles of mechanics.

ponent parts: this belongs to analysis. However, these things do not take place in every instance, for all analyses are not perfect; often we do not perceive the composition which we seek, but by comparing the properties which it manifests with those formerly known from synthesis, without being able entirely to decompose it. In like manner, all syntheses do not completely succeed, and we may reasonably suspect that they are often accompanied with decompositions which alter their truth. The objections of Deluc against the new theory appear to me to arise from these circumstances; and without admitting them, they ought, in my opinion, to render us very circumspect about the consequences we may deduce from experiments, so long as we are not sufficiently acquainted with the nature of the effects of light, heat, electricity, and, in general, of substances which are incoercible.

The same reasons which caused the synthetical mode of proof to be adopted in all the sciences, when the geometers only proceeded by theorems and corollaries, induced the metaphysicians of the middle of the last century to call that method analytical which they made use of to manifest their discoveries. Mathematics at that epoch enjoyed all the consideration which chemistry and physics have acquired since. The mathematicians who succeeded Newton had perfected those theories which he only hinted at, and resolved questions which he was not able to effect by the assistance of analysis. The metaphysicians were willing in some manner to associate their labours with those of the mathematicians, and to attach the revolution they had made in the system of ideas to that which Newton had made in the system of the world. But without being imposed upon by words, let us examine whether their method merits the name which they have given it, at least when it is compared with mathematical analysis.

The writings of Condillac will furnish us with examples of this method. In his treatise upon sensations, he commences by supposing his statue solely to possess the sense of smell, all others being abstracted; and he examines into the nature of the ideas possible to be acquired solely by this sense. In passing to the second chapter of this work, I perceive, in the first paragraph, a definition; in the second and third paragraphs true theorems, that is to say, propositions first enumerated, and afterwards proved by tracing them up to identic ideas. By reading forwards in the same chapter, and the remainder of the work, we may perceive that he advances in a manner analogous to that followed in

elements of geometry; he proceeds from simple to composite. The understanding, or more especially the rapidity with which the faculty of comparing ideas, and presenting their result, exercises itself, conducted him to assertions, the truth of which he afterwards demonstrated by developing all the intermediate propositions, which his judgment had led him to consider nearly in the same manner as gamesters estimate, almost at a glance, what they have to hope or fear from the different chances which are able to present themselves. This is much the same as what is called synthesis in geometry. This synthesis may be said to have been preceded by an analysis; for the author decomposed the system of sensations in order to discuss what regarded smell alone. The same takes place in geometry; and something equivalent to this analysis may be found in the diverse abstractions made by geometers to simplify their subject: thus they deprive a body of two of its dimensions, to form lines. It is not possible to find in the methods of Condillac, that proceeding of mathematical analysis which consists in supposing the question resolved, which it is probably impossible to apply to the things which he has treated upon.

By examining his logic under the same point of view, I think we may convince ourselves that it proceeds according to the synthetic method. In fact, this proceeding may be unknown as such by those who have been struck with the difficulty of understanding the propositions which Newton, for example, has demonstrated synthetically. But this is merely an illusion which may easily be destroyed. The proceedings of Newton might be understood with the same ease as those of Condillac, if all the truths which he has manifested were to follow each other as closely as those which we meet with in the works of the latter. But the interval that separates them, both from each other and those which are admitted as elementary, is so great; the number of intermediates to compare, and frequently to apply, is such, that the most continued application and profound talents are necessary to be employed, in order to avoid being lost in the series of consequences.

There is no doubt but, by establishing all the intermediate links, we might make the Principia of Newton as easy to be comprehended as the Elements of Euclid. In a word, that might take place here which probably does in the natural classifications of animals and plants; if all the species were known, we might pass from one proposition to another by almost insensible transitions. It is easy to perceive

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that in the Elements of Euclid there are to be found a grea number of places in which it is very necessary that all the intermediate truths should be exposed; they were not known to the inventors, and it would be difficult to produce them although their existence is evident.

Analysis produces these intermediates, and makes them pass under the eyes of the operator, although in an inverse order; and when they become so numerous that it is impossible to express them otherwise than by algebraical formulæ, it then becomes necessary to employ calculation; and this makes known truths to which otherwise the reasoning faculty could never attain.

It will sometimes happen, that synthesis, by representing things much simpler than analysis, will lead to a conclusion in a much less complex manner. The researches upon the attraction of spheroids by Maclaurin, are a remarkable instance of this circumstance; but in the hands of Lagrange, Laplace, and Legendre, analysis re-assumes, in these cases, those advantages which it possesses in all others.

I think that to all those who have clear notions of the method employed by geometers, it will appear proved from what precedes, that the true method of analysis has never been applied to metaphysics, which does not appear susceptible of this application, at least in the present state of science.

It is not because Locke and Condillac made use of the analytical method, that metaphysics made such great progress in their hands, but because they sought their first notions from nature, and not from their imaginations; it is because they ascended to the true origin of all our knowledge, rather than create a system according to their fancy. If the first geometers had been willing, or perhaps able, to form to themselves other notions of the right line and circle than those they received from nature, doubtless they would have formed a geometry which had no resemblance to that of nature, but would have been entirely imaginary. The method of geometers is not the sole cause of the certainty of their results; this certainty is principally owing to the nature of the notions which they have to combine. It is possible for a mathematical demonstration to be obscure, embarrassed, and incomplete, and yet at the same time to conduct to the truth of the enunciated proposition any person who shall have the patience and sagacity necessary to follow and rectify this demonstration. This takes place from mathematicians employing only complete notions, or such that the property which forms their principal character excludes all others. When they wish to reason upon

notions of another kind, they often find themselves deceived, notwithstanding all their exertions to preserve rigour in the form of the demonstrations; a thing which no one will dispute their knowledge of.

It is therefore less in the method than in the simplicity and evidence of first notions, that the certainty of reasoning consists; and with regard to general principles, which Condillac always speaks of with merited contempt, they have no place in geometry. That of the least action, which Maupertuis made so much noise about, has only been regarded by mathematicians as an analytical result, arising from the general laws of mechanics; and it has never been exactly defined but by the assistance of mathematics; for it formerly assumed very different forms in the hands of metaphysicians.

The second and third articles of the *Pensées de Pascal* appear to me to contain what is most luminous upon the manner of reasoning; and I do not perceive that Condillac has made any improvements to them. Already Pascal had perceived the abuse of definitions, and reduced them to their just value, that is, to descriptions and impositions of names; but far from proscribing any method of reasoning, as has been done latterly, by calling that synthesis which was but the abuse of reasoning, he classed the different methods of treating the sciences in such a manner as to show the assistance which might be derived from each of them.

It is possible, says he, to have three principal objects in the discovery of truth: the first, to discover it when we seek it; the second, to demonstrate it when we possess it; and the last, to distinguish it from false when we examine it.

In fact, these three cases are able to present themselves; the first evidently almost always takes place; it likewise sometimes happens that the analogy of circumstances makes a proposition suspected, and then we endeavour to assure ourselves of its existence by a formal demonstration. Lastly, if we wish to submit a proposition to examination, in order to discover its truth or falsity, it is useful to know the general means for fulfilling this end.

With regard to the exposition of acquired notions or known truths, the only rule to be observed as often as possible consists in comparing them in those parts in which they have the greatest connection, and where the fewest intermediates are required.

By calling, as is most proper after the etymology of the words, that synthesis, by means of which we proceed from simple to composite; and that analysis, which returns from

composite

composite to simple, we shall see that these two methods almost always meet together: there are no complete truths but what result from their concourse; but they vary a little in their form, according to the nature of the subjects to which we apply them.

To unite synthesis with analysis at all times that we are able to make use of both; to exert the most scrupulous attention in the enumeration of the different appearances which the various cases of the proposition we examine present, in order to assure ourselves that all are comprised in the considerations upon which we found it; that is to say, if the connection of ideas is observed; it is to this small number of principles, in my opinion, that all the art of reasoning should be reduced*. But this art, like all others, cannot be acquired but by continual and well-directed exercise; and all times when the theory is forced beyond a certain limit, it appears to lead the human mind from one error to another, and to present a vicious circle which produces all the subtilties of the antient schools. In fact, if nothing appears that ought to limit the progress that may be made, by applying this reasoning to those sciences which rest immediately upon ideas acquired by the senses; it is not the case when we wish to analyse by themselves the operations of the understanding. It is possible, in this case, for the same circumstance to take place as sometimes happens in mathematical researches, when by some error we combine one equation with another, which only differs from it in appearance; but being in fact the same, it does not aid the solution of the proposed questions, but gives a result purely identic. In the mathematics this result, which falls immediately under the senses, and is also expressed by signs which are well determined, cannot be mistaken; but when forced to turn our thoughts to subjects not susceptible of the same precision, we deceive ourselves so far as to regard as essential modifications, those trifling appearances which the intensity of understanding, which is exercised when the mind dwells too long upon one thought, produces in the manner of judging and perceiving—nearly as the sight becomes confused with being fixed too long upon one object. We think

* The fifth article of the *Elémens de Philosophie*, given by D'Alembert in tome 4. of his *Mélanges de Littérature*, and the Supplement to this article (tome 5. pag. 46.) contain, in a few words, all that is necessary to know upon the natural mechanism of reasoning. With respect to the different forms which can be given to syllogisms, they are to be found exposed in a manner as short as luminous, in tome 2. *des Lettres d'Euler à une Princesse d'Allemagne.*

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to give a substance, if I may so express myself, to those fugitive deceptions, by creating new modes to design them, or by combining, in a different manner, words already known; and we afterwards blindly treat upon these hypothetical abstractions: but as they are exposed to the foundation, there comes a time when the absurdity of the consequences derived from them shows their want of solidity. We then seek a new path, and in general find one formerly trodden, in which we again lose ourselves.

It is probable we commenced by perceiving, in our sensations, the origin of our ideas; but being obliged to class, divide, distinguish, and abstract the different circumstances which the acquired ideas presented, we lost ourselves in the catagories, and all the abstractions which are attendant upon them. The discoveries in physics, by giving a real subject for reasoning, opened the eyes to the abuse which had been made of it. The road traced by Newton in the third book of the Principia, could not be restrained solely to the objects to which it had been applied. The eclat of the discoveries which he made by following it, excited in those who cultivated the sciences an emulation which soon produced improvements in metaphysics. It is to be granted that they have gained much by this revolution; but there may possibly come a time when its progress will be stopped; and by comparing what it has lost on one hand and gained on the other, we shall know that this alone, amongst all the sciences, is susceptible of a limited progress, and that there exists in the theory of the operations of the understanding a point which cannot be gone beyond.

Let us turn, therefore, to the physical sciences, which promise numerous and useful discoveries, all the activity of our understandings; and the theory of probabilities, by becoming familiar to all those who cultivate the moral sciences, will give solid bases to those parts of our knowledge which are not capable of being ramified to a small number of abstract notions and complete ideas.

XXXV. *An Attempt, by a comparative Analysis, to discover the Affinity, if there be any, between the Gealic and Greek Languages, or the Relation they bear to one another.* By CUTHBERT GORDON, *M. D.*

Greek.	Gealic.	Mutual Roots.	Literal English Translation.
ΑΡΧΗ.	Arr'chi. ...	Arr—Chi.	Arr—Attend; Chi—See and understand; *i. e.* an axiom, rule, or exordium.
ΑΚΜΑΖΩ. .	Ekmaso. ..	Ek—Ma—So.	Ek—At or advanced to; Ma—Its Goodness, Increase, Maturity, or Perfection; So—This; *i. e.* any thing come to its full increase, maturity, or perfection.
ΑΓΝΟΣ. ...	Agnass. ...	Agn—Ass.	Agn—Spirit or Vigour; Ass—Wanting; *i. e.* want of spirit or vigour.
'ΑΚΡΟΣ. ...	Ekross.	Ek—Ross.	Ek—At, advanced or come to; Ross—Seed; *i. e.* the top or full growth of Vegetables.
'ΑΤΗ.	Haté.	Ha—Té.	Ha—It is; Té—Scorching or burning hot; *i. e.* not to be touched without danger; noxious.
'ΑΤΥΧΕ'Ω. .	Hatuchiu. .	Ha—Té—Chi—U.	Ha—It is; Tu—Black or Ruinous; Chi—See; U—Thou; *i. e.* you see it is black and ruinous; adverse Fortune, bad Luck.
ΑΤΥ'ΖΩ. ...	Hatutuso. ..	Ha—Tu—Tu—So.	Ha—It is; Tu—Black; Tu—Dreadfully Black; So—This; *i. e.* Fear or Terrour.
ΒΙ'Α.	Biha.	Bi—Ha.	Bi—The inflammable Matter or Phlogiston unsealed, or disposed so as to strengthen the Heart of Man; Ha—It is; *i. e.* Food or Nourishment.
ΒΙ'ΟΣ.	Bioh.	Bi—Oh.	Bi—The Phlogiston; Oh—Out of, or Elevated; *i. e.* the Phlogiston or inflammable Matter elaborated into Life or Spirit. In Gealic, Bioh is the most common vocable for Life, if not the only one.

Greek.	Gaelic.	Mutual Roots.	Literal English Translation.
ΒΙΑΤΑΣ. . .	Biaghtas. . .	Bi—Aght—Ass. . .	Bia—Food or Nourishment; Aght—Swelled big, lifted up, or proud; Ass—Out of; *i. e.* a pampered Animal, unruly, violent.
ΓΗΡΑΣ. . . .	Gerass.	Ger—Ass.	Ger—Sharpness of Sight, and quickness of the natural Faculties; Ass—Are gone out of him or have left him; *i. e.* old Age.
ΔΥΧΕΡΗΣ.	Duchiriss. .	Du—Chir—Iss. . .	Du—Black or intricate; Chir—It appears; Iss—To be; *i. e.* any thing difficult to be overcome.
ΔΕΜΝΙΟΝ.	Dimnian. . .	Dim—Ni—An. . .	Dim—The Time; Ni—That nothing; An—Is done; *i. e.* sleep, a Bed.
ΚΑΚΟΣ. . . .	Kakus.	Kak—Us.	Kak—Ordure, naught, or rottenness; Us—Thou art; *i. e.* close fisted, impudent, base, naught.
ΒΟΥ.	Bou.	Bo—U.	Bo—A Cow; U gives it the plural number; *i. e.* a drove or head of Cattle of the Cow kind.
ῬΕΩ.	Rheo.	Rhe or Rhi—O. . .	Rhe—To flow; O—From or out of; *i. e.* to flow or run as Water from its Fountain or Spring.
ῬΙΟΝ.	Rhivon. . . .	Rhi—Von.	Rhi—The Run or Stretch towards the Sea; Von, the oblique case of Mon—Of Mountains, Hills, or Deserts; *i. e.* a Promontory.
ῬΙΣΚΟΣ. . .	Riskos. . . .	Risk—Os.	Risk—The inner Bark or Rind of a Tree, or Skin of an Animal; Oss—Out of; *i. e.* any thing for holding or keeping clothes, &c. in, made out of the rind of a tree or skin of an animal; a Basket, a Trunk, &c.

Greek.	Gealic.	Mutual Roots.	Literal English Translation.
ΕΥΓΕΝΗΣ.	Eughenles.	Eu—Ghen—Les.	Eu—Worth or Merit; Ghen—Was conceived in the Womb; Les—With him; *i. e.* one of innate goodness.
ΕΝΘΕΟΣ.	Andheus.	An—Dhe—Us.	An—In; Dhe—God; Us—Thou art; *i. e.* thou art inspired.
ΖΥΜΗ.	Scum'e.	Scum—Ha.	Scum—Frothy or in Ferment; Ha—He is; *i. e.* frothy, wrong-headed, or little worth.
ΘΕΟΣ.	Dheus.	Dhe—Us.	Dhe—The Power Supreme; Us—Thou only; *i. e.* God.
ΙΕΡΑ.	Ierah.	I—Er—Ah.	I—The Mind; Er, the oblique case of Pherr—Of Man; Ah—The Presence; *i. e.* the Spirit or Mind of Man lifted up in Prayer to God; divine Service; Prayer.
ΣΑΤΤΑ.	Sattah.	Sat—Tah.	Sat—An overcharge; Tah—To himself; *i. e.* to glut or cloy one's self.
ΣΚΕΔΑΩ.	Skedad.	Sked—Ad.	Sked—Scattered or dispersed; Ad—They are; *i. e.* rooted.
ΣΟΦΟΣ.	Shophiss.	Sho—Phiss.	Sho—Take or receive; Phiss—Knowledge; *i. e.* Wisdom, Circumspection, &c.
ΣΤΙΛΕ.	Stileh.	Sti—Leh.	Sti—It is wanting, or less; Leh—One half; *i. e.* any thing of little value.
ΙΑΚΕΡΟΣ.	Hagerass.	Ha—Gher—Ass.	Ha—It is; Gher, the oblique case of Ker—Fat; Ass—Is wasted or gone out of him; *i. e.* a tabial state of Body.
ΜΑΛΚΕ.	Malkha.	Malk—Ha.	Malk—Approaching or towards a Mortification; Ha—It is; *i. e.* approaching to a state of mortification through intense cold or otherwise.
ΛΩ.	Lo.	Lo.	Lo—To wish one well; the Gealic says Shilo—Peace be with them; good will to mankind.

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The preceding comparison shows a striking connection between these two languages; and it is more than probable the Greek was derived from the Gealic: let the analysis, therefore, be prosecuted a little further by analysing the Greek numerals through the Gealic; the comparison may still throw more light upon this curious and interesting matter, and, consequently, upon the antiquity of the Gealic language.

THE GREEK NUMERALS.

N. C.	Greek.	Gealic.	Gealic Roots.	Literal English Translation.
1.	῞EN.	A'n or E'n.	Ah—An.	He is; the Presence; I Am.
2.	ΔΥΟ.	Duo.	Du—O.	Du—The Black; O—Out of; *i. e.* out of the thick Darkness.
3.	ΤΡΕΙΣ.	Druis.	Dru—I's.	Dru—Penetration or Incubation; I's—Of the Spirit; *i. e.* the Incubation or Operation of the Spirit.
4.	ΤΕΣΣΕΡΕΣ	Tesseres. ..	Tess—Er—Es.	Tess—The Preserver or Guard; Er—Of man; Es—He is; *i. e.* the Intellect; the Mind: the Gealic says "Tesseres mi Ghia—Preserve me, God." The word that the Greek adopts for Four is very different in pronunciation from the Gealic Cheaher; but the sense or meaning of both the same, though the Gealic may be more full and explicit.
5.	ΠΕΝΤΕ. ..	Nenthe. ...	Nen—Dhe. ..	Nen or Nan—The same; Dhe—God; *i. e.* the same God or Power as the Almighty, and therefore to be alike worshipped. The Greek word for Five differs also in pronunciation from the Gealic Coigh'd, but the meaning or sense of both is precisely the same.

P. C.

P. C.	Greek.	Gealic.	Gealic Roots.	Literal English Translation.
6.	ΕΞ.	Ecssi.	Ecs—si.	Ec's—With him; Si—Is the Peace; *i. e.* He is the Peace.
7.	ΕΠΤΑ.	Sip'ta.	Si—P'ta.	Si—The Peace; P'ta—To Man; *i. e.* the Peace to Mankind; the Comforter.
				The Greek ἑπτα differs wholly in pronunciation from the Gealic Shiachd; but in sense and meaning expressly the same.
8.	ΟΚΤΩ.	Uchdah.	Uchd—Ah.	Uchd—The Breast; Ah—The Presence, the Almighty; *i. e.* the God of the Breast; Charity; Universal Love.
9.	ΕΝΝΕΑ.	A'nnaomh.	Ah—An—Na--Omh	Ah—The Presence; An—Is; Na—As; Omh—The Lamb; *i. e.* Innocent, Pure, and Holy.
				The Greek mode of writing number Nine differs from the Gealic manner of writing that number; but in point of pronunciation and meaning is much the same.
10.	ΔΕΚΑ.	Deico.	Deic—O.	Deic, the imperative of Dec—Depart; O—Hence; *i. e.* depart or withdraw from this Place.

The above and preceding analysis show, that the Greek, having no roots of its own, is only a dialect of the Gealic, by whose roots it may be at any time analysed with ease and certainty; it also appears that the Greek retains in its numerals the Gealic precept almost entire.

London,
November 23, 1804.

XXXVI. *On*

XXXVI. *On Blasting with Gunpowder.* *By* J. Farey, *Esq.*

To Mr. Tilloch.

SIR,

Observing, this day, among the original communications in a cotemporary journal, the use of *sand* recommended by an eminent engineer, for stopping in the charge of gunpowder intended for blasting or splitting rocks; who states the usual practice to be, after introducing the powder, "to ram up the remainder of the hole with stone pulverised by the operation of ramming it;" and which operation he justly states to be tedious and dangerous; I am induced to state, for the information of such of your readers as it may concern, that, during a temporary residence at Hallifax, in Yorkshire, in the year 1782, I frequently observed the quarry-men, in the neighbouring hills, blasting the rocks, and using *coal-cinders* roughly pulverised, and very slightly rammed into the hole, upon the powder round the priming-wire. I made no minute at the time; but, if my memory serves me correctly, I think two inches or even less of the hole, thus filled with cinders, was sufficient to retain the requisite charge of powder.

In the year 1784, after heating some pit-coal in a gun-barrel, with the touch-hole closed, and a tobacco-pipe cemented by whiting into its muzzle, to show some friends the raising of bubbles of soap, and other experiments which the rage for balloons then suggested (and among them the producing of a continued flame, or light, by means of the inflammable air separated from the coals, which has lately been shown, and rather pompously announced in a pamphlet from the Lyceum in the Strand); on unscrewing the breech-pin, and attempting to clear the barrel of the very tender and spongy cinder it contained, by punching it out by means of an iron rod, I found it could not be penetrated or started forwards by the strongest blows of a hammer, although the end of a rod a little flattened afterwards bored the whole out, in a few seconds, with perfect ease. I have little doubt but a few inches of cinders rammed into artillery, upon the charge, would effectually burst such pieces as were intended to be destroyed. *Brick-dust* and the *clay* plastering of an old wall I have seen used with success in some places instead of cinders in blasting rocks. It is not altogether foreign to this subject to mention, that I had occasion, in the year 1801, to visit one of captain Mudge's stations in

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the grand trigonometrical survey, on the top of Quainton-hill, near Aylesbury; and being surprised, while there, by a considerable explosion, I hastened to a pit, near where some workmen had just blasted a large piece of rock into fragments. On inquiring their process, they assured me they used no gun-powder, but simply undermined the rock for about a yard in length, and half a yard in depth, and introduced a small faggot of brush-wood, furze, or a bundle of straw, into the cavity, and set it on fire, and that, in a few seconds, the confined air in the stone blew up with great force. The fragments of the explosion I had heard, were lying about, much the same as they would have been thrown by a blast of gunpowder. I saw in the pit several other excavations forming under blocks of two or three feet thickness, intended to be blasted up in the same manner: but night was approaching, and I was unable to stop to witness the next explosion, or to collect further particulars; which I have many times since regretted. Should this singular mode of blasting be practised in other places within the knowledge of your correspondents, they will be rendering me and some others a service by communicating the local and other particulars.

I am, sir,
Your obedient servant,
J. Farey.

12, Crown-street, Westminster,
Dec. 1, 1804.

P. S. Blast-holes are frequently required to be made horizontal, or even inclining upwards; in which case dry sand would be inapplicable as a stopper.

XXXVII. *On preventing the Freezing of Water in Pipes.* *By* J. T. Barber, *Esq.*

To Mr. Tilloch.

The discovery of an effectual means of preventing the freezing up of water-pipes has long been a desideratum in science; but although some methods have been proposed, they have either been so troublesome or expensive, or partially applicable, as not to prove calculated for practical use; simplicity and cheapness, being essential to the general introduction of any contrivance for the above object, must be considered inseparable from the invention that would aim at public utility. In submitting to consideration the following plan, therefore, I only lay claim to the merit of pointing out

out how principles already known, may be accommodated to this useful end in every family, without material trouble or expense. In my family the invention has been in use with the most satisfactory effect; and if it is duly made known, I have no doubt but that the inconvenience which families labour under from a want of water in winter, will, in a short time, be no longer known. The nuisance of water-plugs in the streets will then be unnecessary, and the accidents to which they lead, in consequence, avoided, as well as the mischief arising from the bursting of pipes.

It will be unnecessary to enter into an argument, in order to prove that the freezing of water in pipes does not take place while the *current* of the supply *continues*; the generality of pipes known are *at all times full of water*, and it is when there is *no current* that the formation of ice takes place. But if we prevent any water from remaining in the pipes, after the current of the supply has subsided, it is obvious that they cannot be frozen up.

The effectual means of preventing the freezing of water in pipes, then, being to allow no water to remain in them, we have only to inquire whether a way of getting rid of this waste water can be devised, sufficiently simple and commodious to be eligible for public adoption.

Now it is known that by tying up the ball-cock during a frost the freezing up of pipes will often be prevented; in fact it will always be prevented where the main is higher than the cistern or other reservoir, and the pipe is laid in a regular inclination from one to the other, for then no water can remain in the pipe: or if the main is lower than the cistern, and the pipe regularly inclines, upon the supply's ceasing, the pipe will immediately exhaust itself into the main;—but as it is scarcely practicable to preserve the leaden pipes in an absolute straight line, their inclination must be rather considerable and uninterrupted, to ensure the whole of the water's running off.

These cases, however, are comparatively but few; various deflexions in laying of pipes are necessarily occasioned, and many are capriciously formed by the workmen not proceeding on clear and regular principles. Thus, if the main and the cistern are nearly on a level; but the pipe, passing from one to the other, has materially to curve, to follow the sloping of the road-way, or to be conducted (more readily perhaps) beneath the arching of a cellar; it will be easily seen, that the pipe must be always full of water, as its whole course is lower than both its openings. But if at the lowest part of its course we make a small hole with an awl, a channel will

be

be formed, through which a current will spirt while the supply is on, and as long afterwards as any water remains in the pipe. This hole may be stopped with a nail in general, and only left open in frosty weather; when the water, which will run to waste at each supply, will scarcely exceed a few pails full. In pipes that are already laid, should the lowest part of the course not be conveniently situated for the draining of the pipe, as in an area, or over a sink, such alteration must be made in shaping the course of the pipe, as will place its *lowermost part* in a convenient situation for *draining*. But in pipes that are to be new laid (if what I have already said is understood) it will be obvious, that when a deflection between the main and cistern is necessary, the lowest angle or part thereof should be fixed in a convenient situation for draining the pipe, as *over a sink*; and to this point the whole of the pipe must incline. I have taken some pains in examining the laying of pipes in manufactories, &c.; and I have met with no instance wherein the necessary deflections of a pipe might not be reduced to *one lowermost angle, to effect the exhaustion of the whole course*.

Should the small current alluded to be found an objection, as continuing during the whole of the supply, the peg need only be removed for one or two minutes, within a few hours after the supply has ceased, when the waste water will be drawn off before a formation of ice can take place.

XXXVIII. *Experiments and Observations on Feathers, and the Down of domestic Fowls. By M.* Parmentier*.

Birds are caught and reared not only for the sake of their flesh, their fat, and their eggs, but also on account of their feathers: the feathers, given them by nature for their clothing, and to form their principal means of flight, are applied to different purposes more or less useful to society.

Some, remarkable for their softness and elasticity, for the beauty of the filaments of which their barbs are composed, serve to overshadow the helmets of warriors, to ornament the head-dress of ladies, to form those tresses and those elegant plumes by which the richest articles are surmounted.

Others, sought for on account of the length and solidity of their barrels, and the facility with which they can be cut at

* From *Annales de Chimie*, No. 151.

 pleasure

pleasure for writing, become the interpreters of our thoughts. Among the Europeans, they form an advantageous substitute for the reeds employed by the Arabs, and for the style with which the antients engraved upon tablets.

There are feathers also proper for filling those cushions, on which, when fatigued with the labours of the day, we repose during the night. It is from among the latter that Luxury herself has selected some of peculiar fineness, lightness, and elasticity, to form of them a bed on which she enjoys gentle sleep.

Plumes and other Ornaments of Luxury.

The most beautiful and most esteemed of all the plumes are those made of the feathers of the ostrich, that singular biped, which has its feet and parts of generation like those of quadrupeds, the head of birds, and the faculty of laying; the stomach and intestines of ruminating animals, and yet the gizzard of fowls; which has its body covered partly with hair and partly with feathers; in a word, which has wings which are not the instruments of flying, but only a kind of balances, with which it supports itself, and easily preserves an equilibrium in the exceedingly rapid courses which it performs in the deserts of Africa.

The plumage of the male is black, with some gray and white feathers; that of the female is brown, and of an ash gray; the large feathers of the wings and tail are white in the male and black in the female.

What in particular distinguishes these large feathers, and renders them proper for making plumes, is, that they are soft, open, and flexible; that their barbs, composed of detached filaments, without consistence and adhesion, are long and full; and, lastly, that the white plumes of the male are susceptible of assuming the finest tints.

The rarity and high price of these ostrich feathers, which are brought to us from the Levant, might, no doubt, have suggested the idea of naturalising these birds in Europe, had it been believed that they were capable of residing in any place but the burning sands of Arabia. But there is another kind of ostrich, that of Magellan, which, inhabiting the cold districts of South America, might thrive in our climates: it would be necessary to introduce it, and to try to multiply the breed, in order to take advantage of its eggs, its flesh, and its feathers.

In the mean time, there is another speculation which would succeed more speedily, and with more certainty; it is to multiply white turkeys, and to employ for plumes the

feathers found on the lateral part of the thighs of these animals. This substitute for ostrich feathers would become useful to commerce.

Besides the large ostrich feathers which are seen waving with so much grace over the head-dress of ladies, there are some taken from other birds which serve also for ornamenting these heads: of this kind are the feathers of the bird of paradise, and particularly the long and beautiful black feathers which proceed from the top of the head of the heron, forming an aigrette, which is balanced on their neck.

Luxury adorns itself also with the feathers of the peacock: the colours of gold and of precious stones which nature has bestowed in profusion on the tail of this beautiful bird, are its exclusive property; those of the golden birds, the humming bird, and others of the large family of the woodpeckers exhibit the freshness and velvety appearance of flowers, the polish of the most brilliant metals, the splendour of the most precious stones, and the variegated and dazzling reflection of the rays of the sun. It has employed, in trimming robes, the beautiful yellow and brilliant feathers of the neck of the toucan. It has not even disdained to use, for the like purpose, the azured feathers of the jay, and with which that in the fable was not contented.

So active a war was carried on some time ago against these birds, in order to obtain their feathers, that the farmers flattered themselves with the hope of being soon freed from them. Unfortunately the rage for the feathers of the jay is over, and that bird continues, as before, to ravage the fields.

Not satisfied with objects of ornament, for which luxury employed those feathers, embellished with the most brilliant colours, the idea has been conceived of rendering them useful.

It is with skins furnished with feathers of the same birds, to which are added those of the swan, duck, diver, pintado, pheasant, &c. that muffs and palatines are made.

The skins destined for this purpose, says M. Vieillot in the *Nouveau Dictionnaire d'Histoire Naturelle*, ought not to be those of birds which have died of disease, or which have been killed in moulting-time; in this case the feathers would drop off, or would not be in a state of perfection. None, therefore, must be employed but those of birds killed in their state of perfection, and stripped off soon after their death, especially when the weather is hot; otherwise the same effects would result from corruption as from disease.

When the skin has been freed from all its impurities, it

is spread over a small table, the plumage downwards, and the feathers previously well arranged over each other. To stretch it better, it is fixed with pins, or with a thread.

The grease and flesh which may adhere to it, are then removed, and the rents in it, if any, are sewed up; the skin is then covered with glue, prepared from a handful of farina, a pinch of common salt, and as much good white wine as is necessary to mix it up and bring it to the proper consistence.

The skin being thus covered is exposed to dry to the north wind, after which it is cleaned by scraping it; which may be easily done, as the glue detaches itself in scales. After this operation, if it still retain any humidity, it must be again covered with glue, and dried as before.

When well dried, it is fixed with thread upon paper, or on a ribbon, to preserve it, and inclosed in a box, the bottom of which is covered with absynthium or rose-wood. If an agreeable odour be required in the skin, it will be necessary, before it is taken from the table, and after it has been scraped, to give it, with a sponge, a stratum or two of some odoriferous composition.

When the skins are those of large birds, vinegar, in which salt or alum has been dissolved, is used instead of wine; several strata of this mixture are daubed over them; the quantity depends on the thickness of the skin.

Writing Quills.

Pens, for such is the name given to the feathers of the wings and tails of birds, to distinguish them from the feathers, properly so called, by which their bodies are covered, are the longest and strongest of all the feathers; those of swans, geese, and crows, are employed in preference to all others for economical purposes, and according to the quality of their barrels.

Thus, the quills of the swan are most esteemed for writing and for forming brushes; those of the goose, which are more plentiful, and almost as good as those of the swan, are more generally used for writing; and those of the crow are more particularly employed for the keys of harpsichords, and by draftsmen in those kinds of drawings which are executed with the pen.

Method of Dutchifying Quills.

The bird which supplies the greatest quantity of writing-pens is the goose. One furnishes quills of ten different qualities; but there always remains on their surface a greasy matter, from which they must be freed to render them pure,

transparent,

transparent, shining, and, in a word, proper for acquiring the necessary qualities. This preparation is generally given to them by the Dutch. Hence the expression of *dutchifying quills* to denote the operation to which they are subjected. I took advantage of the circumstances of the war, when several apothecaries, acquainted with the arts and sciences, were employed in Batavia, to request them to procure some information in regard to a process which is still very little known. The following is the substance of what was communicated to me:

The process consists in immersing the quill, when plucked from the wing of the bird, into water almost boiling; to leave it there till it becomes sufficiently soft; to compress it, turning it on its axis with the back of the blade of a knife. This kind of friction, as well as the immersions in water, being continued till the barrel of the quill be transparent, and the membrane as well as the greasy kind of covering be entirely removed, it is immersed a last time to render it perfectly cylindrical, which is performed with the index finger and the thumb: it is then dried in a gentle temperature.

Feathers and Down for Cushions.

Pillows, mattresses, and cushions, may be filled with the small feathers of domestic fowls and pigeons. There are some cantons in which they are employed for this purpose; but for the most part the down of the palmipedes is chosen. Those of birds of prey might be employed also, were they sufficiently numerous to promise abundance.

There are two kinds of down. One, which is neglected, consists of light soft barbs, open, bristly, and without connection, which cover a great many young birds soon after birth, and which drop off in proportion as they are developed. The other, more adherent, which are carefully collected, consist of those short feathers, with slender barrels, and long, equal, disunited barbs, with which nature has composed the warm clothing of birds which take a high flight, and those which are aquatic, in order to secure them from the cold they would otherwise experience, the one in the upper regions of the atmosphere, and the other from the contact of the water. This down in the latter is covered with a close oily plumage, which preserves it entirely from humidity, and by these means permits these birds to preserve their natural heat.

The down of birds of prey, known under the name of *eider down,* being, as already said, exceedingly rare, collectors endeavour to obtain only that of palmipedes; a very

numerous class of birds, and of which three species only have been subjected to the condition of domesticity; viz. the swan, goose, and duck.

But before I speak of the collecting of these three kinds of down, which are readily obtained, I shall say a few words in regard to a kind of down which is far superior to them on account of its softness, lightness, and elasticity; it is the *eider down,* furnished by a duck called the *eider duck* (*Anas mollissima* Linn.), which inhabits Iceland. The following is the description given of it by Sonnini, the worthy friend of Buffon, and one of the principal co-operators in the *Nouveau Dictionnaire d'Histoire Naturelle:*

"The eider duck pulls from its breast and belly the down with which they are covered, in order to line its nest to warm its eggs and its young. It is sought for with great care in all countries where these birds are common. It is the softest, the lightest, warmest, and most elastic of all the kinds of down. Norway and Iceland furnish this valuable substance, which is sold there at the rate of a pistole per pound when pure and well picked.

"The nests of the eider duck are in the north of Europe, to the inhabitants of the coasts, a sort of property which though free is constant and certain. Each individual enjoys in peace the nests situated on his land, and does every thing in his power to draw thither these ducks. A heavy fine is imposed on those who kill any of these birds. One man, if his habitation be placed on one of the rocks at a distance from the land, can collect in a year from fifty to a hundred pounds of down. The Danes purchase all they collect. But it is a general rule that the down taken from a dead eider duck is inferior in quality to that which it plucks from its own body." I have already made this observation, and shall here add that it is general for all birds.

There is, indeed, a very great difference between feathers plucked from a living animal and those taken from one which has died in consequence of disease. The latter have very little elasticity; their barbs become matted when exposed to the least humidity. They are attended also with another inconvenience, which is, that though baked in an oven they are attacked more readily by insects, and in a little time reduced to dust.

But this difference is observed not merely in the feathers of domestic animals; wool and hair are equally subject to it. Wool shorn from an animal which has died of disease is not nearly so valuable as that cut from a sheep in good health. The state of the disease even lessens the quality

lity in a considerable degree. All cloth made of hair cut from an animal which has died of disease is destitute of strength. Merchants, therefore, are very careful to say that their hair is the product of a living animal; and they are no doubt taught by daily practice to distinguish it.

Even ivory which is collected by chance in countries inhabited by elephants is inferior to that obtained from elephants which are hunted: the latter being whiter, less brittle, finer, and susceptible of a better polish, and in every respect superior.

XXXIX. *Observations on some Dutch Processes in regard to the Arts and Sciences. By M.* Parmentier *.

As we have had a camp at Utrecht, and as government attached to it M. Payssé in the quality of apothecary in chief, I flattered myself, from the knowledge I have of the zeal and talents of that chemist, that by requesting him to take advantage of his stay in Batavia to examine the cabinets of natural history, to visit the workshops, laboratories, and manufactories, and particularly to frequent the company of the professors with whom I maintain a correspondence, it would be possible to obtain some useful information in regard to certain processes of which the Dutch seem to have been in exclusive possession since time immemorial. My hopes have not been deceived; and I shall here give an extract of the different letters I received from M. Payssé: it is he himself who gives an account of what he collected in his excursions.

"Our camp at Utrecht is very beautiful, and as advantageously situated as local circumstances will permit. Water is good and abundant. The evenings are rather cool, in consequence of the ground having very little shelter, and of the condensation of the water with which the air is always saturated. There are not so many sick as we at first imagined; and we hope that in the autumn, which is the season of disease to military people in this country, we shall have very few, or a much smaller number of sick than we have in our hospitals, in consequence of the means of salubrity which have been recommended to us, and the great care employed both in the camp and in the hospitals.

"I have had the pleasure of spending a day at Leyden

* From *Annales de Chimie*, No. 151.

with

with your friend M. Brugmans, and, after visiting every thing curious in his cabinet and that of the academy, we conversed on your ideas respecting the preservation of eggs. This celebrated professor is of opinion that your process is the only method proper for the proposed object. The ship captains whom I consulted assured me, that when going on long voyages they took on board a very large quantity of hens without cocks, and that to preserve the eggs which they laid they put them in large wooden boxes, or pots of earthen ware, arranging them in strata and covering each of them with half an inch of chaff of sarazin, commonly called in French *boquette*. The boxes, when well filled and shut, are inverted every day. The bran of wheat, sometimes employed for this purpose, does not seem to be so proper. The ashes of turf, wood, &c. may be substituted in the room of these two matters.

"Eggs which have been fecundated by intercourse with a cock, cannot be kept so long by the same processes as the preceding; but if they are put into an earthen-ware pot, or any other vessel capable of holding melted butter in order to cover them, they may then be secured from putrefaction for a very long course of time. Some inclose them in small barrels with successive strata of sea salt. The vessels are inverted every two or three days, to change their position.

"From Leyden I went to the Hague, where I visited several cabinets of natural history. The most remarkable are those of Messrs. Voet and Froost, and especially the former. One of the members of the Batavian council, to whom M. Brugmans was pleased to recommend me, showed me the central dispensary of the military hospitals of that nation, as well as the laboratory where the chemical preparations are made. Besides the good order which I remarked in that establishment, it appeared to me that every thing was prepared with exactness; and that the simple drugs employed were well chosen and of the best quality.

"One thing which interested me much was the machine used for pounding the greater part of the roots, bark, &c. It consists merely of mason-work, covered with a plate of cast iron having a rim of about nine inches in height. The plate is about eight feet in diameter, and from the middle of it arises an axis having at the extremity a pinion which communicates with a large horizontal wheel moved by a horse. From the axis proceed two iron arms which are fixed to two vertical millstones, placed opposite to each other, and which, by the motion communicated to them, reduce to powder the substances they meet with in their passage.

Each

Each of these millstones is furnished with a machine which raises and changes the place of the matter to be pounded, so that in a short space a very large quantity of any dry drug whatever may be pulverized. The sifting is performed on a large scale by bolting cloths like those used for wheat, the tissue of which is exceedingly fine.

"The same mechanism puts in motion eight large knives arranged four and four in a large vessel somewhat conical, and hollowed out in a block of wood nearly four feet in diameter and two in depth. This apparatus is employed for cutting medicinal roots, &c. It is much to be wished that similar means were employed in the military hospitals of France. This apparatus has œconomy and every thing else in its favour.

"From the Hague I went to Harlem to see M. Van Marum, to whom I was recommended. This learned man took the trouble to accompany me to the different cabinets of the university, and the academy of which he is director. I saw there a collection of minerals, the specimens of which are exceedingly fine; but it is not complete. The physical cabinet is superb: I saw there several instruments improved by M. Van Marum himself; and particularly Lavoisier's gasometer.

"At Amsterdam I took an early opportunity of paying my respects to the society of the Dutch chemists, Messrs. Vrolick, Deyman, Paff, &c. This city contains some interesting collections; such as those of birds of Messrs. Ray, Temminck, &c. I had here an opportunity of forming an acquaintance with a drug merchant, who superintends, on his own account, a chemical laboratory, where several products are fabricated on a large scale. I visited his manufactory, where I saw a refinery of borax, furnaces, crystallizators, and other apparatus. I examined all his glass vessels, and every thing employed on a large scale for the fabrication of corrosive sublimate, red precipitate, mercurius dulcis, cinnabar, sal-ammoniac, spirits, and for the purification of oil of turpentine, &c. The same merchant has a manufactory also where he refines camphor, alum, and carmine; but I must observe that he would not allow me to see the processes he employs for the last three. In regard to every thing else, I acquired, notwithstanding my short visit, a good idea of whatever I saw: the form of the sublimatory vessels, the furnaces, their sand-baths; nothing escaped me.

"I made a sketch of an alembic according to the modern form, which seems to me to unite many advantages. I have

I have substituted for the spiral tube an instrument difficult to be constructed and repaired, a metal cylinder, as this matter appears to me preferable to glass, wood, earthen ware, &c., in consequence of the property it possesses of being a good conductor of caloric. This reason is sufficient to convince me that the cooling of the liquor in distillation will be effected more speedily. I have not settled the dimensions which ought to be given to this instrument: this point must be relative to the application intended to be made of it. The diameter of the still ought always to exceed the height, &c. The furnace for placing it on ought to be constructed according to the principles of the celebrated Lavoisier. A large quantity of liquid may be distilled in a short time, and with little fuel, by means of this apparatus.

"During my instructive tour, I did not fail to procure information from different learned men and booksellers, in regard to the domestic œconomy of the Dutch; I was told by Messrs. Brugmans, Van Marum, &c., that there were some dissertations on this subject scattered throughout the transactions of learned societies. There is, however, a work entitled *La Cuisiniere Hollandaise*; but, as you supposed, it is of as little value as those of our country distinguished by similar names: I shall however translate the most useful parts of it, to enable you to judge whether the processes in it are worth your attention. There are some articles in it so ridiculous, that they will excite your laughter. The Dutch, who are exceedingly provident, have not forgot to accompany the formulæ for the preparation of their different dishes with medical recipes; so that their alimentary code contains every thing suited to people both in a state of health and disease.

"In the Dutch domestic œconomy there are a multitude of processes for preserving legumes throughout the whole year: there are three for prolonging the duration of French beans without sensibly altering their colour: the first is, to cut the pod into small rhomboidal portions while it is yet tender, and when the seeds begin to assume their form. When this operation, which is performed by women, each armed with a knife, is ended, a stratum of the beans, about an inch in thickness, is placed in an earthen or wooden vessel. This stratum is besprinkled with a handful of pounded muriate of soda; other strata are added, besprinkled with muriate of soda in the like manner; and these alternate layers are repeated till the vessel is filled to within about two inches of the brim, care being taken that the last stratum shall be muriate of soda. A piece of board, of the size of the

the diameter of the vessel, is then placed over the whole, and loaded with a weight sufficient to compress it strongly, and the vessel is deposited in a cellar: at the end of five or six days the surface is covered with a certain quantity of water, arising from the solution of a portion of the salt in the juice of the legume. This liquor is decanted; after which a new solution of the same salt more saturated is added. At the end of eight days, the operation is renewed with the same precaution; the liquor thrown aside becomes acid in the course of some months, which announces that the greater part of the mucous matter of the fruit has been in a state of fermentation; this acid taste has a great analogy to that of the oxalic acid; I am even inclined to think that the latter predominates, and perhaps I shall have an opportunity of confirming it. After a similar preparation of two months, these beans may be used at table: before they are boiled, they are washed in water: by these means a great part of the saline matter with which they are impregnated, as well as the acid, is removed: when boiled they retain a slight acidity, which gives them a very agreeable taste.

"Another method of preserving French beans consists in taking them nearly in the state of the preceding; cutting them only in two, or according to their length; freeing them from their filaments, as is done in regard to the former, and boiling them for a quarter of an hour in water: they are then taken off and suffered to drain on a table: when cold they are put into earthen-ware pots, in alternate strata, with common salt; the vessel is covered in such a manner as to be hermetically closed; and they are deposited in a cellar, where they are left untouched till the time of their being used, which is in winter: they are then washed and boiled.

"A third process for preserving these beans is, to take them very green and tender, and boil them in water for some minutes, after which they are hung up in a proper place to dry.

"Some people, to preserve to French beans their green colour, adopt the pernicious practice of adding salt to them, and macerating them for some time in a copper vessel; they even put among them pieces of copper coin. The same method is employed in the preparation of cucumbers: in regard to the latter, some boil them in vinegar strongly saturated with pepper; others only pour boiling vinegar over the fruit in a vessel; some also suffer them to macerate cold, adding the common spices, tarragon, elder flowers, onions, &c.

"I have observed that cucumbers, prepared by ebullition in

in vinegar, have the most agreeable taste; those macerated cold always retain a green taste, and are not so tender as the former.

"Red cabbages, which are exceedingly fine in this country, and particularly in Belgium, are prepared in the same manner as the white cabbages are for *sauer kraut*; they are delicious food, and preferable to the real *chou croûte*. I think it needless to describe the process, as it is so well known in France; but it is applied here to red cabbage, and even to turnips, as is practised in some countries of Germany.

"The potatoes here are of a very fine kind, and will keep throughout the whole year; we eat them even in the spring time and summer, yet they do not appear to have lost any part of their quality: instead of keeping them in cellars during that season when the frosts are to be apprehended, the Dutch spread them out in a barn; they partly become so dry, that the germ cannot be developed. To boil them, they put them into a large kettle, taking care to add no more water than is sufficient, when reduced into vapour, to penetrate each tubercle, and to separate the farinaceous moleculæ. By this method they are always good. This practice, as you have proved in your works, has a great influence on their quality.

"The Dutch are accustomed to preserve the root of the ginger, and the *calamus aromaticus*; in this state they are much employed as a tonic; they are used in particular after dinner, and in the evening.

"To prepare them, they pick and clean the roots, free them from the rind, and cut them into pieces about an inch in length; they then boil water in a bason, throw the roots into it for some time, in order that they may become soft and lose some of their acridity: when sufficiently tender, they are carefully taken out and suffered to drain on a sieve. This operation is called *bleaching*: a syrup, of a good consistence, is then made with sugar, in which the roots are suffered to macerate for twenty-four hours; next day the whole is placed over the fire, and gently boiled till the roots are well dilated, and impregnated with the saccharine matter. The vessel in which this operation is performed, the object of which is to render them very tender, ought to be well closed, that the evaporation of the aqueous liquid may be effected only with difficulty: the whole is then left at rest for twelve hours, taking the vessel from the fire on the third day. The syrup is then concentrated, and brought to a strong consistence: the preserve is afterwards put into vessels of glass or of

earthen ware well closed: the roots must be covered with syrup only to the depth of some lines.

"Sometimes a dry consistence is given to these roots; for this purpose they are immersed in sugar *cuit à la grande plume*, leaving them to drain and to dry at each operation. If it be required to have them candied or crystallized in sugar, they are left in syrup of very white sugar boiled to a strong consistence.

XL. *On the Principles of Pump-Work, illustrated and applied in the Construction of a new Pump, without Friction, or Loss of Time, or Water, in working; humbly proposed for the Service of the British Marine, with the Privilege of His Majesty's Royal Letters Patent. By* Benjamin Martin*.

In a civilized nation, every person, considered as a member of the community, is, by the first law of nature, obliged to exert every faculty in his power towards establishing, supporting, and preserving the public good; since the happiness of individuals must result from, and therefore is necessarily dependent upon, that of the commonwealth. And when every thing is duly considered, no person will be found endued with talents not considerable enough to render them of importance to the public some way or other.

There is no case wherein this maxim of politics is more conspicuously verified than in that of sea-faring men. The marine is well known to be the bulwark of every commonwealth circumstanced like ours; and therefore the life of every man in that respectable and momentous body must deserve the first regard of the higher powers, or regency of such a state.

But when we consider their mode of living, as it were, founded in instability, and liable to all the fortuitous events that the four elements can expose them to, their situation merits all the care of government, and the concurrent asistance of every person in the community, to protect them against

* This article is copied from a pamphlet by the ingenious Benjamin Martin, with which we were favoured by a friend. As the pump described in it possesses great merit, and many advantages over any pump we have seen, it ought to be generally known; which we find it is not, though the invention was published in 1766. The same kind of piston is, if we recollect right, noticed in Desaguliers's Natural Philosophy, but only applied to one working barrel; one great advantage in Mr. Martin's pump arises from employing two.—We gave an engraving of this pump in our last Number, Plate V.

against the numberless casualties that hourly await them, fluctuating on the surface of the ocean.

Among these perils by sea, we may justly reckon a leaking ship the most dreadful and fatal of all others: here not only one man or a few men perish, but every creature breathing on board the sinking ship, the brave commander with the meanest of the crew, are equally devoted to destruction by such an irresistible catastrophe: if a ship strike against a rock, and is wrecked, some lives may be saved by floating planks and rigging: if the magazine takes fire, death comes instantaneous, and kills, perhaps, in the most gentle manner: but, in the desperate case of a leaking ship, how slowly does the awful monarch advance, arrayed in all the terrors possible! How are all their united forces successively applied, and as constantly defeated by the unabating torrent, which rushing in, and gradually overpowering them, plunges them at last into the bottomless deep!

Now, as in such a melancholy situation all their hope and expectation of help and safety must be placed in the pump, of what prodigious estimation and consequence does such a consideration render that machine! and how much must it import every commander of a ship (to whom the lives of his men are committed) to take the utmost care that the ship be supplied with such pumps as will best provide against and ward off those impending dangers! By any negligence in this respect, he may become guilty of destroying his own life, the lives of his men, and of the ruin and misery of many families. It is therefore his duty to see that his ship be furnished with the best pump that can be procured for evacuating the hold of the water that may at any time get in, with the least force and in the shortest time.

Here, then, a question of the most serious concern will naturally offer itself for discussion; viz. whether that hydraulic machine, called a chain-pump, now used in ships, be as proper and effectual a construction to evacuate the ship as that of a real pump; I say a real pump, because the chain-pump is not such,—and, properly speaking, it is no pump at all.

Now, by considering the true nature of a pump, I apprehend, it will appear that its structure is the best adapted to answer the above purpose of any machine whatsoever, because it will raise just as much water whose weight is equal to the force of the men employed; and to pretend to any thing more would be absurd.

I here speak of the just or genuine construction of a pump, such as it ought to be; and not such as are in com-

mon

mon use, for they are faulty in many respects, particularly the two following: 1. They have, in general, a great deal of friction, to overcome which a part of the given force must be applied. 2. One half of the time employed in working them is lost: and since every moment of time is precious in a ship that has sprung a leak, it is evident a common pump is by no means to be depended upon in any such pressing exigence. These are two essential defects of structure; I pass over all circumstantial ones that render their application on ship-board every way improper.

The effect of a pump is, with a given force, to raise the greatest quantity of water to a given height, in the shortest time. From this definition it follows, that every pump, or hydraulic machine, which has any friction, or loses any water in its operation, must, in its own nature, be unfit for all naval purposes. And that one or the other of these deficiencies is inseparable from the structure of a chain-pump, must be evident to every intelligent person; for, if the pallets touch the pipe, there will be friction; and if they do not, there will be loss of water, which is the same thing as loss of time. Therefore it is manifest a chain-pump cannot be used in a ship without hazarding the loss of the ship, the cargo, and the lives of all his majesty's subjects on board the same.

It will be in vain to allege any thing in favour of a machine which is in its own nature bad, and of dangerous consequence to be used; to say the lower part of the pipe is so fitted to the pallets that the water raised cannot there run out and be lost, is to confess a friction; for no person who understands the force and effect of the pressure of the atmosphere, will pretend that any pump or engine whatever can be made water-tight, without friction to a degree superior to the pressure of the air; since by the pressure of the air the water endeavours to descend between the piston and the barrel, which can only be prevented by the close application of some springy substance about the piston, as cloth, leather, &c., producing the friction above mentioned.

The chain-pump is not only subject to the friction of the piston and water-pipe, but to much more besides, arising from the two wheels and axles in each: from the common principles and experiments of mechanics, it appears that near a third part of the power is lost in most mechanical machines, as being employed to overcome friction unavoidable in their structure; and this impediment we shall in vain attempt to remove by friction wheels in the chain-pump, whose con-

 struction

struction is necessarily too clumsy and coarse to admit of any benefit from such nice applications.

I take no notice here of the small power (or purchase, as it is called) that the manner of working this pump allows of; nor the great disadvantage of applying the power in a circular motion; with many other things that one would think no judicious mechanic could ever appear an advocate for. And therefore it must be presumed the chain-pump could never have continued so long in use, but because other pumps, not subject to the same imperfections and inconveniencies, have not, as yet, been offered, though many have been contrived and proposed in lieu thereof.

The ill success of others, however, has not deterred me from speculations of this kind. I thought, if pumps could not be made without friction and loss of water or time in working them, it should seem as if nature itself had been in this case wanting in its usual perfection. But as no such thought could be admitted, it was clear to me that the most perfect method of constructing pumps had not yet been made public. As I knew it was a matter of the last consequence, I applied myself to consider which way water might be raised without friction or loss of time; and with little reflection, it appeared that nothing was wanting but a right application of the several parts concerned in the structure of a pump, to make it answer all the purposes which could be expected from the principles of hydrostatics, hydraulics, and mechanics, all united together.

That the public may have no doubt of this, I have for their satisfaction given a summary of all those principles (as far as pump-work requires), and illustrated the same in a variety of copper-plate figures: every position or principle here advanced the reader may find demonstrated in my *Philosophia Britannica*, and *Physico-Mathematical Institutes*. These principles I have here put together in one view, as I know of nothing more wanting in our language, to assist the mind in forming a right judgment of the nature and due construction of a pump. And I must further observe to the reader, that whoever may think fit to criticize upon the pump here offered to the public, unless he is known to understand these principles, his judgment, objections, or censure, ought to pass for nothing.

However, it would, after all, be trifling with the public to talk to them about a pump in theory only. I knew so well the nature of the construction which the theory directed to, that I made no demur about putting it into execution at large;

large; and when I had finished it, I found it answer all my expectation, and, indeed, beyond what the common theory of pump-work required.

For, as the theory has hitherto considered a pump consisting only of a single barrel and piston upon the sucking pipe, it supposes that no water rises into the barrel but while the piston is ascending; which is true in all common or single pumps: but in a double pump, or that here proposed with two barrels upon one pipe, the case is otherwise; for the water not only rises while the piston rises, but continues to do so even after the piston begins to descend; and therefore we soon found the pump delivered more water than was expected from calculation.

To account for this hydraulic paradox, it must be considered, that as this pump has both its large pistons working (alternately ascending and descending) at the same time, there must be produced a constantly rising column of water in the pipe, whose velocity through a bore of five inches to supply the barrels of twelve inches diameter each, must be so great, that it cannot be checked or stopped at once, or upon the first descent of the piston, and therefore a surplus of water must be produced, as we found there acually was, by the experiment.

This is therefore an argument which alone proves the superior perfection of this construction of a pump, as such an effect can never be produced in any other.

How deservedly this pump may be considered as without friction, will appear from its own nature, and from experiments that have been made upon it. With respect to the nature and construction of the piston, it is evident that no friction can arise from thence; for, while any body is in a fluid, it is affected by a pressure every way equally, and is therefore in the same condition as if it was not acted upon by the fluid at all; that is, it will be absolutely free to move. Now this is the case of the leathern pistons in this pump; they touch not the surface of the barrels, but produce their effect by a motion of the several parts in water only, and therefore entirely preclude even the very possibility of friction from that quarter.

The only source of friction, then, must be in the axle, arising from the pressure of the lever, pistons, &c. But how very small and inconsiderable this is will be evident from two experiments made on a pump at large, viz. the height sixteen feet, the diameter of the piston twelve inches, and the length of the stroke nine inches.

Experiment I.

The double lever (of iron) and both its pistons weighed 178lb.: and less than one pound weight laid upon the end of the lever or handle, made it descend directly; which plainly shows the friction arising from the pressure of 200lb. is not more than equal to one single pound weight; a sufficient proof of the great simplicity and perfection of the structure of this pump.

Experiment II.

After this, the axle was laid upon the surface of perpendicular moving bars of twelve inches in length, which were tantamount to friction wheels of two feet diameter; and it was found that much about the same weight, viz. nearly one pound, was then also necessary to make the end of the lever preponderate. Whence it appears, that the friction of the axle may be entirely neglected, or, being so very small, may be esteemed as nothing.

This fact was also further verified by the men who worked the pump; for they all unanimously declared, that they found not the least difference whether they worked with the friction bars, or without them. These are all convincing proofs, that the construction of this pump is not liable to the common objection of friction.

As to the other imperfections of pump-work, viz. loss of time, and which is unavoidable in common pumps, it is as evident, that it can have no place here, as being inconsistent with the very construction of the pump; for, since one piston or the other is always ascending, the water (conducted in one pipe) must be always rising; therefore no time can be lost.

Neither will the construction of this pump admit of any water being lost in working it; for it is self-evident, that it has such a structure of the pistons and valves, as necessarily renders them not only water-tight but air-tight likewise; and consequently no water is necessary, and no time lost, in fetching this pump, as is the case with all others of the common construction.

Long after this pump was erected, and its effects publicly shown, it was objected by some, that the invention was not new; for it could be proved that, years before, pumps had been made with two barrels upon one pipe; and also that leather had been applied to a piston for raising water without friction before now. To all this I answer, 1. That I had never heard of any such construction of two barrels upon one pipe, when I made mine. 2. That upon inquiry, I find no

no such application of the barrels to the pipe in them, as appears in mine, where the course of the water from the pipe is directly into each barrel; but in them it is very oblique, and the force of the water must be greatly broken. 3. None of these double-barrelled pumps have pistons, like those in mine, without friction. 4. The leathern piston above mentioned was applied to a single pump, and not in a double one, as in mine. 5. This leather piston was of a different form from mine, and admitted of but a very short stroke. 6. Not only the construction, or application of the parts of this pump is very different from that of all others, and their essential defects thereby removed; but it is attended with many circumstantial advantages which cannot fail of recommending it to all who have occasion for a machine to raise water.

The great velocity and force with which the water rises in the pipe, carries up every thing that lies in the way, as heavy pieces of iron, &c.; therefore it is plain it can be no ways liable to be choked as other pumps are too often, as is well known by fatal experience.

One thing here is of too great importance not to be mentioned, viz. that whereas in common pumps a fissure or crack in the water-pipe, by which the air can get in, stops the operation of the pump entirely; in this pump, if the fissure be not very large, the water will continue to rise, as we have experienced by making a hole in the said water-pipe 1-fourth of an inch wide. An effect, I believe, never before heard of in pump-work.

The structure of this pump is so very simple that it cannot be often out of order; and when it is, it may be rectified in a very short time, without any difficulty or trouble.

And a peculiar advantage in this pump is, that while one piston is mending, the other may be kept working; and how great a succour and relief this must afford to the dejected mariners in a leaking ship, they best can tell whose lives have been deeply endangered by an unavoidable cessation of the operation of the pump.

This pump may be made of any size, and constructed with an air-vessel, as in the common stream engine for putting out fire; may be wrought with men, water, wind, horses, &c. for all the purposes of raising water to supply reservoirs, extinguish fires, water gardens, evacuate ponds, &c.

[To be continued.]

XLI. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones.* *By* DAVID MUSHET, *Esq. of the Calder Iron-Works.*

[Continued from p. 141.]

2d, Calcareous Ironstone.

Of this class there were subjected to experiment two varieties: one in the state of band, or regular stratum; the other in the state of calx: the former containing about 25 per cent. of iron, the latter 42.

The first variety of calcareous ironstone is found about two inches in thickness, and is inclosed in a regular stratum of shelly limestone, mentioned in last communication. The fracture of this stone is smooth and dense, exhibiting a great number of calcareous lines which describe the exterior lineaments of muscle shells. It roasts to a very fine purple colour, and displays every appearance of a rich ironstone. The calcareous lines, however, soon attract moisture, swell, and burst the ironstone, first into masses shaped like muscle; but soon after an entire decomposition takes place, and the ore passes into the state of a fine powder, assuming a deeper shade as it falls.

This band or stratum is the companion of coal metals; and wherever found indicates the existence of coal with an almost unerring certainty. Its enveloppe by burning forms good lime, which has in some cases been deemed to make excellent mortar. The two substances, though not homogeneous, yet adhere so strictly together that they cannot be separated distinctly till after burning.

The extent of this measure or stratum is so general, that in almost every coal field it may be met with; and there is no iron-work in Scotland but the same ironstone is found modified in some shape or other.

Exp. I. 400 grains of raw ironstone was fused *per se.* The result was a very black shining glass, in which there were found no traces of metal.

Exp. II. 400 grains of ironstone,
$13\frac{1}{3}$ —— of carbon, or 1-30th.

There resulted from the fusion of this mixture a shining black glass, porous upon the surface and round the edges. Below was found a fine shaped gobule of iron, weighing 9 grains: equal to $2\frac{1}{4}$ per cent.

Exp.

Exp. III. 400 grains of calcareous ironstone,
20 —— of carbon, or 1-20th.

The fusion of this mixture afforded a glass equally black, but more shining than the last. A crystallized button of steel was obtained which weighed 29 grains, and equal to 7¼ per cent.

Exp. IV. 400 grains of ironstone,
27 —— of carbon, of 1-15th nearly.

The result as to glass was very similar to No. III. The metallic button was coloured, and still more elegantly crystallized. Its weight was found to be 37 grains, or 9¼ per cent.

Exp. V. 400 grains of ironstone,
40 —— of charcoal, or 1-10th.

The result was a triangular-shaped button of crude iron, which weighed 68 grains: equal to 17 per cent.

Exp. VI. 400 grains of ironstone,
55½ —— of carbon, or 1-7th nearly.

The chief part of this mixture was reduced to glass, and detached globules of iron, which could not be collected with any degree of accuracy. A portion of the mixture, very magnetic, was found upon the surface of the glass. The glass itself was of that pure flinty nature which always indicates a saturation of coaly matter in the mixture.

Exp. VII. 400 grains of ironstone,
80 —— of carbon, or 1-5th.

The same circumstances were produced in this as in the former experiment. A portion of very fine glass was formed, more transparent than in No. VI. The quantity of globules appeared greater, though equally diffused. A much greater portion of the mixture remained unfused, and which seemed to increase in proportion as the charcoal is augmented.

Recapitulation of experiments with first variety of calcareous ironstones: quantity of matter 400 grains.

Exp. I.	*Per se*; no metal obtained.					per cent.
II.	1-30th	of carbon yielded of metal		9 grs.	or	2¼
III.	1-20th	ditto	——	29	or	7¼
IV.	1-15th	ditto	——	37	or	9¼
V.	1-10th	ditto	——	68	or	17
VI.	1-7th	ditto	imperfect.			
VII.	1-9th	ditto	ditto.			

Experiments made with the same calcareous ironstone in a roasted state, after having ascertained that in torrefying it lost of water and carbonic acid 42 per cent.

Exp. I. 400 grains of roasted ironstone,
13⅓ —— of carbon, or 1-30th.

This

This mixture was easily reduced, and a perfect result obtained. A smooth, stained, shining metallic spherule was obtained weighing 17 grains: equal to 4¼ per cent.

The glass, as is usual in the early stages of separation, was very black and dense, and its upper surface was covered with enamel of purple oxide.

Exp. II. 400 grains of roasted calcareous ironstone,
20 —— of carbon, or 1-20th.

The fusion of this compound afforded a handsome shaped button of metal which weighed 30 grains; equal to 7½ per cent. The glass was nearly the same as obtained in last experiment. The oxide enamel was more shining, and not so deeply incrusted.

Exp. III. 400 grains of roasted calcareous ironstone,
27 —— of carbon, or 1-15th.

The glass obtained in this fusion was in thin fragments, possessed of a dull amber shade. A smooth skinned metallic button was obtained which weighed 60 grains, or 15 per cent.

Exp. IV. 400 grains of roasted calcareous ironstone,
40 —— of carbon, or 1-10th.

There resulted from the fusion of this compound an elegant crystallized button of cast steel, the surface of which was covered with a variety of prismatic colours.

The weight of the regulus was found to be 116 grains; equal to 28 per cent.

The glass had received a very perfect impression from the button of steel, and contained in concave lines an exact copy of the crystallization.

Exp. V. 400 grains of roasted ironstone,
55½ —— of carbon, or 1-7th.

The result of this experiment was a perfect fusion, accompanied by a very fine button of crystallized cast steel. Upon the upper surface there were several circular spots of a bright silvery colour, marked with the most minute, yet perfect, lines of crystallization. This result was found to weigh 146 grains; equal to 36½ per cent.

Exp. VI. 400 grains of roasted calcareous ironstone,
80 —— of carbon, or 1-5th.

This compound was exposed to 160° of Wedgewood. When cold I found the following result:

A considerable portion of the mixture was found upon the surface of a pure flinty glass. This was interspersed with a number of globules of cast iron beautifully carburated. One solid mass was found of the quality of white cast iron, which, with the globules, amounted to 180 grains; being

being equal to $32\frac{1}{2}$ per cent. This is 4 per cent. less than in No. V, and is no doubt occasioned by part of the compound forming an infusible residuum at the temperature at which the mass entered into fusion.

Recapitulation of experiments made with roasted calcareous ironstone, first variety.

						per cent.
Exp. I.	1-30th	of carbon yielded of metal		17 grs.	or	$4\frac{1}{4}$
II.	1-20th	ditto	——	30	or	$7\frac{1}{2}$
III.	1-15th	ditto	——	60	or	15
IV.	1-10th	ditto	——	116	or	28
V.	1-7th	ditto	——	146	or	$36\frac{1}{2}$
VI.	1-5th	ditto	——	130	or	$32\frac{1}{2}$

It would appear to result from these experiments, that when a large portion of carbonaceous matter is used, there results an imperfection in the reduction, which, though neither of the same magnitude nor importance as was experienced in the argillaceous compounded ore, or with that compounded of siliceous matter, yet is equally extensive with the deficiency remarked in the argillaceous ironstone treated of in the last communication. The metallic produce in the case of the argillaceous ironstone appears to be retarded by a quantity of the iron still remaining in the state of glass of iron, over which the carbonaceous matter does not seem to act during the short period of reduction with full effect.

In the case of the calcareous ironstone, the want of complete reduction, or the deficiency of the metallic product, arises from a very different cause. The glasses are found perfect, containing little or no iron; but a portion of the compound is formed, by means of the agency of the calcareous earth, into a dull magnetic carburet of iron, which resists the highest heat of the furnace.

If this reasoning upon facts that seem sufficiently established by experiment be correct, then the present calcareous ore either contains too much lime or too small a proportion of iron to make a perfect reduction without the addition of another earth. To prove this the following experiments were made;

Exp. I. This was No. VI, with raw calcareous ironstone, repeated in the following manner:

200 grains of ironstone,
$28\frac{1}{2}$ —— of carbon, or 1-7th nearly.
50 —— of sand, very pure.

This mixture was completely reduced without an atom of any

any matter whatever being found within the crucible when cold. A pure flinty glass was obtained, and covered the metallic result, which was found of the quality of cast steel. Its weight, including two small globules, was 42 grains; equal to 21 per cent.; and 4 per cent. more than was obtained in Experiment No. V, with 1-10th of carbon.

Exp. II. 200 grains of raw ironstone,
28 —— of carbon; or nearly 1-7th,
50 —— of Sturbridge clay.

The result of this fusion was an irregular shaped button of iron weighing 35 grains, or 17½ per cent. No part of the mixture remained unfused. The glass was of a black colour and very dense, with every appearance of containing a portion of iron.

It would appear to result from this and the former experiment, that a mixture of 1-4th of sand is of more service in reviving the metal of calcareous ironstones than an equal weight of clay.

The second variety of calcareous ironstone operated upon is found in the shape of oval balls weighing about 7 pounds each. The external colour is rusty yellow. The fracture is splinty, of a grayish white colour and porcelain appearance.

Exp. I. 400 grains of raw ironstone yielded a very ponderous glass, dense, and free from honeycombs throughout, and without any symptoms of revived metal.

Exp. II. 400 grains of raw ironstone,
13⅓ —— of carbon, or 1-30th.

The fusion of this mixture formed a glass nearly the same as in No. I. In the middle of this glass I found a perfect globule of iron which weighed 4 grains; equal to 1 per cent. The surface of the glass was deeply enamelled with oxide, and the fracture of a dazzling metallic lustre.

Exp. III. 400 grains of raw ironstone,
20 —— of carbon, or 1-20th.

From the fusion of this I obtained a very fine spherule of iron which weighed 25 grains, and equal to 6¼ per cent.

Exp. IV. 400 grains of raw ironstone,
40 —— of carbon, or 1-10th.

This mixture when fused yielded a beautiful smooth button of metal weighing 68 grains; equal in point of product to 17 per cent. The glass was still black and shining: the fracture in point of lustre resembled the polish of a highly finished razor-blade.

Exp. V. 400 grains of raw ironstone,
57 —— of carbon, or 1-7th.

A metallic

A metallic button resulted from the fusion of this mixture weighing 112 grains; equal to 28 per cent.

The surface of the glass was covered with an enamel of a pearly white colour: the fracture however was still black and shining, and in thin fragments very opake.

Exp. VI. 400 grains of raw ironstone,
80 —— of carbon, or 1-5th.

There resulted from the fusion of this mixture a large button of white fractured cast iron weighing - 162 grs.
About 50 globules mixed with a small portion of untaken up charcoal - - - - 3

165

Equal to $41\frac{1}{4}$ per cent.

The glass obtained was of a foul brownish rusty colour; but the quantity did not exceed 20 grains, and was attached to the sides of the crucible only.

Exp. VII. 400 grains of raw ironstone,
100 —— of carbon, or 1-4th.

The result of this was precisely the same as last. The quantity of iron $41\frac{1}{4}$ per cent. The glass the same in quantity and in colour. Eight grains of charcoal remained untaken up.

Recapitulations of experiments made with the second variety of calcareous ironstone.

Exp. I. fusion *per se*, yielded no metal.

							per cent.
II.	1-30th of carbon	yielded		4 grs.	of iron,	or	1
III.	1-20th	ditto	——	25	ditto,	or	$6\frac{1}{4}$
IV.	1-10th	ditto	——	68	ditto,	or	17
V.	1-7th	ditto	——	112	ditto,	or	28
VI.	1-5th	ditto	——	165	ditto,	or	$41\frac{1}{4}$
VII.	1-4th	ditto	——	165	ditto,	or	$41\frac{1}{4}$

The specific gravity of these three varieties of ironstones was as follows:

Argillaceous ironstone - -	2·984
Calcareous, first variety -	3·124
Ditto, second variety - -	3·550

[To be continued.]

XLII. *Com-*

XLII. *Comparison of the Cow-Pock with the Small-Pox.* *By Dr.* THORNTON.

[Continued from p. 152.]

NEITHER is the cow-pock attended with sore throat or diarrhœa. Its entrance into the system may be marked by a fever of one or two days' continuance; but this should excite no alarm, as there is no danger from it, and shortly the whole constitutional affection will have subsided. In the small-pox there is often a *secondary* fever more to be apprehended than the first. When the fond parent had hoped that the danger was over; when the eyes begin to open; the swelling of the limbs to subside, dawning reason to return, and food be craved after,—expectation fancies that her doubting fears have ceased for ever;—soon the deceitful calm is only the prelude to a more direful scene: the matter formed in the first fever, or effort of Nature, is again taken up into the frame, and, with weakened powers, assailed in every part by the circulated poison, unable further to resist, she yields at last to the renewed attack of her most powerful enemy.

From extensive experience, it may now be pronounced, that none die of the cow-pock, either taken naturally or from inoculation.

The cow-pock *never kills, the natural and inoculated* small-pox *not unfrequently.*—If the whole merit of the cause of *vaccine inoculation* depended on this single point, it might rest secure as the greatest discovery ever made. *The cow-pock never destroys life!*—Glorious tidings!—Happy annunciation!—I who have lost by *variolous inoculation* my first-born child; a boy who, not alone in his parent's eye, but to all who knew him, promised the fulfilment of every wish, have a just right to exult in the present fortunate discovery of Dr. Jenner. How was his lovely form defaced, and what were his sufferings, before death snatched him to an early tomb, has been drawn by me with a trembling hand, when I wrote my detail of the symptoms and account of the ravages of the small-pox!—So faithful is the portrait, that I have often witnessed tears to flow in abundance when this history has been read by others, as bringing to recollection many a similar distressing scene exhibited by some favourite child, or by some friend's or relation's child.—*My* tears are *now* wiped away; and may *theirs* be also, by the *pleasing view* of the *present ameliorated condition of humanity!*

The cow-pock never disfigures the countenance.

To all who have the refined sentiment of taste, and contemp ate

template the human form as the master-piece of creative power, and acknowledge that female charms are destined by the ALMIGHTY as the zest of otherwise a vapid existence, must grant every praise to the *Jennerian discovery*, which is never known to disfigure (as does often the natural and inoculated small-pox) "the human face divine."—Although external appearances are not of themselves solely to be desired; I ask, where is the parent who does not wish for her daughters to possess a pure unblemished heart in an elegant and pleasing person?—For often, at the very first glance, the soul takes fire, and soon after joins in holy bands of wedlock the two sexes destined by PROVIDENCE to make each other happy. But, when the features are all changed, the nose drawn inward, a speck perhaps in both eyes, and horrid seams pervade the pallid cheek—the mind of sensibility revolts at the ruins of fair nature, and marriage is prevented, unless for the sake of sordid pelf!—I shall here beg leave to make a quotation from Dr. Beddoes's "*Hygeia**." "What impression," says this sagacious writer, "do not a sallow unwholesome complexion, *seams from the small-pox*, scrophulous scars, and those marks which debauchery is apt to stamp upon the face, make upon the spectator? Is he not in general disposed to turn away in disgust from these appearances? or, if politeness forbid him to give way to his feelings, do they not rise to a greater height for being suppressed? And in what manner does the mind of those who perceive themselves to be objects of aversion react?—Instead of going for an answer to the theory, which explains how our habits are formed, I shall bring one of the most sagacious of self-observers to speak for himself. The late professor, J. George Busch, whose memory the city of Hamburgh is at this moment employed in honouring, tells of his having had the *small-pox* at nine years old; and, though they were attended with no imminent danger, they left him *badly marked*. 'I was afterwards informed,' says this philosopher, 'that previously to this affliction I had a comely appearance. For myself, I had never attended to the point. But one thing I know well. After this time, I perceived that those who visited my parents universally withheld from me that kindness of attention, which with a child is the first motive to render himself agreeable, though

* "*Hygeia, or A Series of Essays on the Means of avoiding habitual Sickliness, and premature Mortality, on a Plan entirely popular*, by Thomas Beddoes, M. D." A work admirably conceived, and likely to be productive of the greatest benefit to the human race.

they showed it to my well-looking brothers and sisters: all the pranks that I, poor *pock-pitted* boy, to whose feet no dancing-master had given the right position, or drawn the head from between the shoulders, played in my vivacity, might indeed, have been performed with an ill grace.

"'This too, I should observe, was the period when the chief art of education consisted in hard words and blows. On me reproaches rained from all quarters. When my parents, who alone treated me with any degree of sense, carried me to Haarburg; my grandmother and a brisk grand-aunt so *maltreated* poor George, that my father and mother were extremely unwilling I should repeat the visit. In my grandfather's favour I stood all the higher, for he was stock-blind; so could not judge of me by my exterior.'—From his subsequent history—particularly from the hypochondriacal complaint into which he afterwards fell—it should seem that this man, wise and useful as he proved, never entirely recovered of the wound inflicted on his tender mind." What then can be hoped where fewer resources exist, and fewer favourable circumstances concur in riper years?

The cow-pock never deprives any one of sight.

There scarce needs a comment on the advantage of the *cow-pock* over the *small-pox*, as here stated. The blessing of vision, so often destroyed by a *small-pox pustule* settling on the eye, is but too obvious to be much insisted on. How feelingly does Milton deplore this loss!

——— Thus with the year
Seasons return; but *not to me returns*
Day, or the sweet approach of ev'n or morn,
Or sight of vernal bloom, or summer's rose,
Or flocks or herds, or human face divine;
But cloud instead, and ever-during dark,
Surrounds me,—from the cheerful ways of men
Cut off,—and for the book of knowledge fair
Presented with an universal blank
Of nature's works, to me expung'd and raz'd,
And wisdom at one entrance quite shut out.

The cow-pock is so mild a disease as rarely to prevent the patient from pursuing his daily avocation.

This is an advantage over the small-pox particularly to be considered with regard to the army and navy.

Dr. Marshall reported to the committee of the house of commons, that he, assisted by Dr. John Walker, commenced, in July 1800, vaccination on board of his majesty's ship

ship the Endymion; eleven of whose crew were inoculated, and went through the vaccine disease without any remission of their ordinary duty, or any deprivation of their usual allowance of wine or provisions. He also inoculated such soldiers of the garrison of Gibraltar as had not had the small-pox: the plague, at this time, prevented the garrison from receiving the usual supplies of fresh provisions from Barbary; and Spain was shut against them by the war: their food, in consequence, was principally salt provisions sent from England, and they generally indulged in drinking new wine: this diet, added to the excesses which soldiers usually commit, put the cow-pock to a severe trial, especially when it is further considered that they, whilst under inoculation, performed their ordinary regimental duties; and so far was the cow-pock from preventing their doing this, that not a single case occurred where any application was requisite to the inoculated part, though the heat of the atmosphere was frequently upwards of ninety degrees; in corroboration of which the surgeon-major's certificate was produced. At Minorca the same success attended the inoculation, where it was also generally introduced amongst the inhabitants; and their medical men were instructed in the practice: such seamen also on board of the British fleet, under the command of admiral lord Keith, as had not had the small-pox were inoculated with the cow-pock. At Malta, its practice was also generally introduced both among the troops and inhabitants; and an hospital, called the *Jennerian Institution*, was established by the governor, for the inoculation of the poor. In this island the ravages of the small-pox had always been dreadful; and some of the men of war then in the harbour had the small-pox on board, and had buried several men: this apprehension was also entertained by the admiral, and the late general sir Ralph Abercrombie, who each issued *general orders* for the inoculation of such seamen and soldiers, under their respective commands, as had not had the small-pox. A certificate, confirming the above facts, was delivered in, signed by sir Alexander Ball, governor of Malta. In Sicily, the small-pox had been, if possible, still more fatal than in Malta; for the computation of deaths, occasioned by it in the year preceding his arrival, exceeded *eight thousand* in the city of Palermo alone: the introduction of the cow-pock was therefore received with *enthusiasm*, and an hospital, similar to that at Malta, was immediately established by his Sicilian Majesty; and although the small-pox, soon after his arrival in the city, again appeared, it was immediately stopped by

vaccine inoculation, which was also extended through the whole island. The benefits received at Palermo from the cow-pock excited a great wish for its practice in Naples, where the small-pox has always been considered as very fatal. An hospital was also there established by his Majesty, and the practice of vaccine inoculation was speedily adopted throughout the whole kingdom; his Majesty having commanded that children to be inoculated, attended by surgeons to be instructed in the practice, should be sent from each province to the hospital at Naples, to carry both the knowledge of the disease, and the practice of it, into their respective provinces. On his leaving Naples the witness received very honourable testimonials from his Sicilian Majesty, which were produced. He also extended his practice to other parts of Europe, to Rome, Leghorn, and Genoa; and in every instance where tried he found it resist the infection of the small-pox. He never heard that any such mode of inoculation had been practised or known in those countries before; and, as an example of the disbelief entertained by the medical men of Naples, he related a trial which they instituted soon after his arrival there, and without his knowledge, at the Foundling Hospital; where they first inoculated with the cow-pox a considerable number of children; and, after they had passed through the disease, *exposed them to all possible modes of infection of the small-pox, both by inoculation and by making them sleep in the bed with people infected with the small-pox.* This trial, which had excited the attention of the whole city, completely established the reputation of the cow-pox; and they appointed a deputation to him publicly to express their conviction of its efficacy.

Public Testimonies.

" General Memor. Foudroyant, Malta, Dec. 9, 1800.

" The small-pox having made its appearance on board the Alexander, and other ships in the fleet, the commander in chief thinks it necessary to refer the respective captains to the general memorandums of the 19th October last, and to recommend immediate application to Dr. Marshall and Dr. Walker, whose safe and excellent mode of treatment has been experienced on board the Foudroyant, and other ships, in preventing the dreadful effects so often attending the small-pox, which may now so easily be avoided without danger or inconvenience.

" By command of the vice-admiral,
(Signed) " WILLIAM YOUNG."

" *To the respective captains, &c.*"

" These

"These are to certify that Drs. Marshall and Walker have administered the vaccine inoculation to such of the crews of all his majesty's ships under my command at Gibraltar, Minorca, Malta, the Port of Marmorice, and on the coast of Egypt, as had the opportunity and were desirous of submitting to the operation: that these gentlemen have manifested the greatest assiduity for the extension of the practice, bestowed the most unwearied attention to its successful application, and have, according to the information I have received from all quarters, exhibited it with perfect success.

"Given under my hand, on board his majesty's ship the Foudroyant, in the Bay of Aboukir, 29th March 1801.

"KEITH."

"Camp, four miles from Alexandria, April 11, 1801.

"This is to certify, that Drs. Marshall and Walker attended at the hospital at Malta for the purpose of inoculating the respective regiments of the expedition to Egypt, according to the general orders of the late commander in chief Sir Ralph Abercrombie, at which time the small-pox had got into the fleet, and was very fatal.

"Dr. Walker accompanied the expedition, with the approbation of the commander in chief, to Egypt, and introduced the new practice into the army in general, which was found effectual in arresting the ravages of the small-pox; those soldiers escaping it, who submitted to this operation, and doing their duty as usual, while a few who neglected the opportunity were laid up.

"We now experience his services in another way, he having consented to be associated with the surgeon of the brigade of seamen on shore; and from Sir Sydney Smith finding it necessary to have the attendance of the surgeon at a distance from the camp, the medical care of the whole brigade falls upon him.

"Major-general Hutchinson feels a sincere pleasure in recommending Drs. Marshall and Walker (for their indefatigable zeal in the service) to his royal highness the duke of York, who ever takes so lively an interest in whatever renders the situation of the soldier comfortable.

"J. HELY HUTCHINSON, Major-General."

As there is no loss of labour, so the expense of the cow-pock is only inoculation, which is usually performed gratis.

The small-pox is a serious evil. What with preparation

 before

before inoculation, inoculation, and the treatment often required during, and always after, the disease, with the absolute necessity of lying by, it is an expense that the generality of mankind are unable and very often unwilling to support.

The cow-pock does not admit the obstacles to a general inoculation which the small-pox does.

The obstacles to a general inoculation of the small-pox are such as in all probability to prevent a plan of this kind from ever being carried into execution.

1st, *The prejudices of the lower orders of mankind.*

The cold calculator may estimate the advantages of inoculation to society, and calculate the *comparative number* of *deaths* from the natural small-pox and artificial disease; but yet, as he must allow that *some* die under inoculation, the fond mother naturally will thus argue within herself: —"Can I bring my mind to consent to what may bereave me of my dear child?—If he were to die, how shall I forgive myself?—Am I sure that I am not anticipating an evil that may never arrive?—Where is my right to do this?—Is he certain to catch the small-pox?—And were this to happen, and he were, alas! to be taken from me at a later period, I shall then, relying on Providence, have nothing to reproach myself with."

In vain will the philosopher oppose to these natural suggestions of the weak mind,

1. That were the child to die under inoculation, the mother has truly nothing to upbraid herself with, having only done her duty.

2. And had not the Almighty designed inoculation to be performed, it would not be endowed with the extraordinary virtue it possesses of preventing the small-pox, and have a nature infinitely milder than the other.

The more ignorant the person, the more stubborn against the conviction of reason; and, as Hudibras says,

> "She who's persuaded 'gainst her will
> Is of the same opinion still."

So here, no force of argument will be able to bring over the unwilling, and words are only lost in the attempt; and a large class of mankind will be *always* found adverse to inoculation, the possibility of death arising to the person inoculated, being the stumbling-block against its universal acception.

2dly,

2dly, *The chances that infants at the breast have of dying; early age being found most unfavourable to the insertion of the small-pox.*

A fact which soon drew the attention of many eminent medical writers, who endeavoured to account for this circumstance. Thus Dr. Percival:

"I. The number of diseases to which infants are liable, render them unfit subjects for inoculation. Hippocrates, two thousand years ago, remarked, *ætatibus morbosissimi sunt juniores*. And when we consider the great and sudden changes, both external and internal, which they undergo at birth; the laxity and wonderful delicacy of their frame; and their extreme irritability, perhaps depending upon it; the copiousness of glandular secretions, with the difficulty of preserving that equilibrium, the least deviation from which affects them; it is matter of real astonishment that life itself can be supported under a series of such apparently unfavourable circumstances. Scarcely hath the little stranger been ushered into the world but he discovers signs of indisposition, by his restlessness, anxiety, crying, and vomiting; by the swelling of his belly, and sometimes by convulsions. These symptoms arise from the load of *meconium* with which the stomach and bowels are oppressed, and generally cease when those organs have been gently evacuated. The jaundice next succeeds, and is sometimes complicated with a very acrimonious state of the fluids, as appears by the eruption of little red pustules, with which the skin is every where loaded. The thrush, watery gripes, and convulsions, observe no regular order of time, but attack most infants, either singly or collectively, according as they are more or less obnoxious to the causes which produce them. The quick growth of children in the first period after birth, is likewise a source of numerous ailments; notwithstanding the provisions which nature hath made to guard against the inconveniences resulting from it, by the laxity of the glandular system. And as most of these causes continue to exert their influence after birth, though in a less degree, the increment of the young animal proceeds apace, and redundances are formed, which in a healthy state are carried off by one or other of the glandular excretions. But a deficiency or excess in any of these, necessarily produces diseases. And in such feeble, delicate, and irritable subjects, the equilibrium cannot long be preserved. If they are defective, all the complaints which arise from plenitude ensue;

 the

the child grows feverish, dull, and comatose; his stomach is disordered; his bowels are oppressed with wind; and if his belly be constipated, he falls into convulsions. On the other hand, if they are excessive, a *diarrhœa* is produced; *aphthæ* and severe gripes succeed; and the violent irritation seldom fails to occasion epileptic fits. From this short view of the first period of infancy, I think it must appear evident that inoculation is ill adapted to that tender season of life. Nature, feeble and irritable as she then is, can scarcely struggle with the diseases to which she is ordinarily exposed. It is therefore equally cruel and unjust to add to the number with which she is already oppressed. For it is demonstrable from the bills of mortality that two-thirds of all who are born, live not to be two years old; and I think it is more than probable, that a considerable proportion of these die under the age of six weeks.

The fears and anxiety of the mother, excited at a time when her strength hath been exhausted by the pains of labour, and when every uneasy impression should be cautiously avoided, cannot fail to injure her milk. And this is a powerful objection to the early inoculation of infants. If a hired nurse be employed, her milk may disagree with the child; she may fall into some disease during the time of inoculation, may be guilty of excess in eating or drinking, or may be under the influence of violent passions; each of which will aggravate the symptoms and increase the danger of the artificial distemper under which the infant has to labour.

"It hath been observed by a very able and experienced practitioner, that young children have usually a larger share of pustules from inoculation than those who are a little further advanced in life; and that, from this circumstance, so many have died as to discourage the practice of ingrafting the small-pox on such delicate subjects. This fact is not easy to be explained. Whether the greater irritability of infants subjects them to be more affected with the variolous *miasma* than children of two or three years old; or whether the larger eruption, to which they are liable, be owing to the proportionably greater quantity of their fluids, I will not presume to determine. Both causes may possibly conspire to produce this effect; the former, by exciting a quicker and increased contraction of the heart and vascular system; the latter, by affording a more copious *pabulum* for the variolous ferment. By the same principles we may perhaps account for the greater virulence of several other

eruptions

eruptions in infancy than in the more advanced stages of life.

"A considerable number of those who die of the natural disease, before the expulsion of the variolous eruption, are infants, or very young children. This does not arise, as Dr. Kirkpatrick supposes, from the extreme weakness of the *vis vitæ* of infants; for the contraction of their hearts is proportionably stronger than in adults, as the quickness of their growth evinces; but from the high degree of irritability with which their nervous system is endued: Hence the convulsive paroxysms which often precede the appearance of the pustules, and which, though regarded by Sydenham as no unfavourable signs, are always alarming, and, when they happen to very young infants, are frequently fatal.

"If the number of pustules be so great in the mouth or throat as to obstruct suction, the disease, in all probability, will prove fatal. Even a few pocks in those parts are highly troublesome and dangerous to infants; for, besides the pain and restlessness which they produce, they often terminate in ill-conditioned ulcers. Under such circumstances the mute wailings, or shrieks, of an infant occasion equal embarrassment and distress.

"Those who are affected with cutaneous diseases have been generally regarded as unfavourable subjects of inoculation. Infancy, therefore, which is seldom unattended with eruptions on the skin, must be an improper period for receiving the small-pox by ingraftment.

"The thickness of the teguments of infants, which arises from the quantity of fluids interposed between their fibres, by which the skin is rendered soft and œdematous to the touch, and their perspiring less than children who are capable of using exercise, are further objections to very early inoculation.

"But the most forcible argument against this practice is deduced fror the ill success which hath attended infant inoculation in general. For it appears by Dr. Jurin's account of the progress of inoculation in Great Britain from 1721 to 1726, and by Dr. Scheuchzer's continuation of it to 1728, that of fifty-eight children under two years old who received the small-pox by ingraftment, *six* died; whereas of two hundred and twenty-one, inoculated between the ages of two and five, only *three* died."

"It is too common an opinion," says that able writer Dr. Underwood, in his Treatise on the Diseases of Children,

 "that

"that a very young infant, sucking at the breast, is the fittest subject for inoculation; and medical people have some difficulty in persuading parents to the contrary. Children are then said to be clear from humours, their blood mild and balsamic, their food innocent, and they are free from all violent passions of the mind. But all these advantages may be counterbalanced by the delicacy of their frame, their disposition to spasm, and their inability to struggle with a severe attack of the disease, if it should chance to fall to their share. And such, indeed, are the facts: infants may have the small-pox very lightly, whether taken naturally or from inoculation, though in both there are a few instances of their expiring in a fit at the time of the eruption; but they seldom get through the disease if they are full, or it prove of the confluent or malignant kind. And this furnishes a peculiar objection to inoculating infants at the breast, which arises from their necessarily lying so much on the arm of the mother or the wet-nurse, especially in the night; the heat exposing them to a much more copious eruption than children who are weaned. This I have seen clearly exemplified in the instance of a child whose mother could suckle only with the right breast; the consequence was, that the left side of the child was perfectly loaded with the eruption, (though the pock was of the distinct kind,) whilst the other had only a moderate sprinkling. The child, however, sunk under the secondary fever at the end of five or six weeks, though turned of two years old; the *only* child I have known to die of inoculation at so advanced an age. A similar instance is related by Mr. Moss; who not being able to prevail on a young woman, whom he had inoculated, to keep her feet (which were very cold) out of the warm ashes of a hearth fire, at the time of the eruption, they were, in consequence, so loaded with it, as to appear one continued blister; though the disease was very distinct, and went on very favourably in other parts.

"I am aware," he adds, "that many children are inoculated very young, and even in the month, and generally with very good success; but the frequency of this practice, among eminent surgeons, is owing to the urgent solicitation of parents, and their fear of contagion. I cannot therefore avoid saying, that however few may die under inoculation, under any circumstances, the fact is, that the far greater proportion that I happen to have had an account of, is amongst infants under six months old. A remarkable proof of this disproportion appeared lately under a general inoculation

lation at *Luton*, during the progress of a malignant small-pox, which carried off one-half of those who were attacked by it in the natural way. In the midst of this fatality, twelve hundred and fifteen paupers were inoculated through the humanity of the Hon. and Rev. Mr. William Stuart, many of whom refused all preparatory medicines, and were besides addicted to the use of strong liquors: nevertheless, out of the *twelve hundred and fifteen* only *five* died—*all of whom were infants under four months old.* Seven hundred adult people of better condition, in the same neighbourhood, were inoculated a short time afterwards, and with the like good success with the former.

"From this view of the matter it is pretty evident, I think, that this operation ought, in general, to be postponed to a later period, which is pointed out by the child having cut all its first teeth."

Dr. Macdonald justly remarks, "that the deaths of infants often happen under circumstances the more distressing."

"Before me lie the records of two unfortunate families. In the one, a father and four of his children were inoculated for the small-pox: the eruptions proved of the confluent kind: *two children* out of the four died. The other is a young widow, who lost her husband at the early age of twenty-four. *One infant* at the breast was left her, which, in her pitiful situation, constituted her only consolation. Soon after, the small-pox began to rage in the city where she lived; she therefore was advised by her friends to inoculate her little boy. With reluctance, as if presaging her impending misfortune, she consented. Her fears, alas! were but too well grounded: on the day preceding the eruption the child was seized with convulsive fits, and expired on the tenth day.

"One smiling boy, her last sweet hope, she warms,
Hush'd in her bosom, circled in her arms;
Daughter of woe! ere morn in vain caress'd,
Clung the cold babe upon thy milkless breast;
With feeble cries thy last sad aid requir'd,
Stretch'd its stiff limbs, and on thy lap expired."—*Darwin.*

3dly, *Dentition is found to be a period in which inoculation was hazardous.*

The small-pox is usually ushered in by convulsions in children at every age. The period of dentition being very

 liable

liable to such convulsive attacks, which often prove fatal, would naturally put the practitioner on his guard against bringing on, or adding to, an event equally terrific, as it is often fatal.

"It cannot be denied," says my learned and eloquent friend Dr. Macdonald, "but the inoculation of the small-pox has proved to mankind a ready means to alleviate and escape the danger of a most distressing disorder: still, notwithstanding these happy effects, the inoculated small-pox is *often* accompanied with symptoms which give just cause of alarm, and *sometimes* prove fatal under the most judicious management.

"Were I to record all the distressing scenes which frequently attend the inoculated small-pox, or relate the sad histories of those unfortunate families, who, in consequence of inoculation, have felt the ragings of this dire disorder, the stoutest heart would shrink with horror, and drop a tear of pity over the sufferings of humanity.

"I would wish to relinquish this subject; for my pen can give but a faint sketch of those pictures of singular distress, which every physician of even moderate experience has witnessed.

4thly, *Old age.*

Although this period cannot be alleged as equally unfavourable to either of the foregoing, it is one a practitioner would not prefer, and it seems cruel to subject a person on the verge of the grave to the chance of a disease that possibly may prove extremely severe.

5thly, *Pregnancy is a situation in which inoculation generally produced abortion, and the death of the individual.*

Cases of this sort are to be found in every author. In Mead we have the following affecting narrative:

"A lady of quality at the seventh month of her pregnancy was seized with the natural small-pox, which proved of an unfavourable sort. On the eleventh day she was brought to bed, and safely delivered of a male child: on the fourteenth she died. On the fourth day following, the infant was seized with convulsions, the forerunner of the eruption, which appeared on that same day, and he died in the evening."

The inoculated disease is found also equally dangerous.

"A physician at Winchester informs me," says Dr. Kirkpatrick in his Analysis of Inoculation, "that in the several

several towns of Hampshire, Sussex, and Surrey, there have been inoculated 2000, of whom *two* only died, both pregnant women, who admitted this operation contrary to the opinion of their physician."

The cow-pock, on the contrary, may be inoculated under all circumstances.

1. *Early infancy.*—Dr. Jenner relates, "that he caused an infant, but twenty hours old, to be inoculated for the cow-pock by his nephew Henry Jenner; and this little stranger, so newly ushered into life, felt but a very slight disease; and, being afterwards inoculated for the small-pox, and exposed to its contagion, *resisted* all attempts to communicate the small-pox."

2. *Time of teething.*—We may adduce here the authority of Dr. Denman, one of the most eminent accoucheurs in London, in confirmation of the experience of Dr. Jenner. "It became now the duty," says Dr. Denman, writing in the Physical Journal for April 1800, "of medical men, especially of those who are much engaged in the practice of inoculating for the small-pox, or who are much consulted in *infantile diseases*, to declare their experience about vaccine inoculation, and examine into it with the greatest possible care. For my own part, I can affirm, that I have seen inoculated with the cow-pock, through my son-in-law Mr. Croft, a great many children *at all ages*, and they went through the disease without the least sign of danger, and even without much fever or indisposition."

3. *Humours in the body.*—As *scrophula* does not appear to be called into action by the cow-pox (*vide* last comparison, p. 250); but, on the contrary, there are cases where this cruel disorder has been found to be not only mitigated by vaccine inoculation, but also wholly removed, the dread of the subject being *humoury* is unimportant. Fat and lean children do equally well. In my experience at Lowther the reader will find a case of *tinia capitis*, which was not at all increased under inoculation. Dr. Pearson has recorded two cases of *psora* (itch), which, being unknown to me at the time, were inoculated; and from the pustule, which was broken, vaccine matter was conveyed to different parts of the body, producing a very severe disease, which appeared *pustular* solely from this cause. The psora, therefore, must be allowed to be a ground of exclusion to this, or any other inoculation: the only exception I am at present acquainted with.

"More

"More than a thousand subjects," says Mr. Dunning, surgeon at Plymouth-Dock, "have been *vaccinated* in this neighbourhood during the last year. Some hundreds of them have fallen to my share. Complete success has been invariable in every case, where the vaccine character has been unequivocally expressed. With a very few exceptions, the indisposition has been none at all, or the least imaginable, and I know of no shade of accident that can fairly be attributed to the new practice. In one child a very general and obstinate cutaneous complaint, which had previously resisted much external and internal medicine, very soon *disappeared* after vaccination. *Health* and *firmness* have shortly succeeded it in several weakly children, under my own observation, and I have heard of many similar occurrences: this has so *often* and so *strikingly happened*, that it has more than once been proposed to me to vaccinate *sickly* children."

4. *Besides humours which militate against the small-pox inoculation, there are variety of diseases, which, if they attack at the same time the child labouring under the small-pox, or soon after, usually prove fatal: a combination, however, not found to become aggravated by, or increase, the cow-pox.*

Miss R——, a young lady about five years old, was seized, on the evening of the eighth day after inoculation with vaccine virus, with such symptoms as commonly denote the accession of violent fever. Her throat was also a little sore, and there were some uneasy sensations about the muscles of the neck. The day following a rash was perceptible on her face and neck, so much resembling the efflorescence of the *scarlatina anginosa*, that I was induced to ask whether miss R —— had been exposed to the contagion of that disease. An answer in the affirmative, and the rapid spreading of the redness over the skin, at once relieved me from much anxiety respecting the nature of the malady, which went through its course in the ordinary way, but not without symptoms which were alarming, both to myself and Mr. Lyford, who attended with me. There was no apparent deviation in the ordinary progress of the pustule to a state of maturity, from what we see in general; yet there was a total suspension of the *areola*, or florid discoloration around it, until the *scarlatina* had retired from the constitution. As soon as the patient was freed from this disease, this appearance advanced in the usual way.

The case of Miss H—— R —— is not less interesting than that of her sister above related. She was exposed to the

 contagion

contagion of the *scarlatina* at the same time, and sickened almost at the same hour. The symptoms continued severe about twelve hours, when the scarlatine rash showed itself faintly upon her face, and partly upon her neck. After remaining two or three hours it suddenly disappeared, and she became perfectly free from every complaint. My surprise at this sudden transition from extreme sickness to health, in great measure ceased, when I observed that the inoculated pustule had occasioned, in this case, the common efflorescent appearance around it, and that as it approached the centre it was nearly in an erysipelatous state. But the most remarkable part of this history is, that, on the fourth day afterwards, as the efflorescence began to die away upon the arm, and the pustule to dry up, the *scarlatina* again appeared, her throat became sore, the rash spread all over her. She went fairly through the disease, with its common symptoms.

That these were actually cases of *scarlatina* was rendered certain by two servants in the family falling ill at the same time with the distemper, who had been exposed to the infection with the young ladies*."

I had a similar case of scarlet fever and cow-pox in the child of Mr. White, coachman, Adams Mews. The efflorescent areola was arrested, but became visible after the scarlet fever ceased.

"I have met with," says Mr. Ring, "three cases of the co-existence of cow-pock and measles within the last six months. The first was in the child of Mr. Shepherd, in Phœnix yard, Oxford-street. The second was the child of ——— Hardey, No. 45, Peter-street, Westminster. This case I showed to Dr. Jenner and his friend Dr. Marshall, of Gloucestershire. It was also seen by Mr. Missiter. The third case was in the child of ——— Groom, World's-end-passage, Newington-causeway."

"Mr. H. Jenner lately met with a similar case.—In these different instances, the periods of the respective eruptions were various. In the first that occurred to me, the measles appeared on the second day, and went through their regular course; yet in no degree retarded the progress of the vaccine pustule. In the second instance the measles appeared on the eighth day; and in the third instance on the fourth day; yet neither distemper interrupted the other. In the case which occurred to Mr. H. Jenner, the measles appeared the

* From Jenner's Inquiry.

eighth

eighth day, without checking the progress of the pustule. In those cases which I have seen, the areola surrounding the pustule was perfect. This was also remarked by Dr. Jenner, in the case which I showed him. Dr. Marshall assured me, that nothing but ocular demonstration of such a case could have convinced him of the possibility of its existence."

"I have had," says Dr. Jenner, "an opportunity of trying the effects of the cow-pock matter on a boy who, the day preceding its insertion, sickened with the measles. The eruption of the measles, attended with cough, a little pain in the chest, and the usual symptoms accompanying that disease, appeared on the third day, and spread all over him. The disease went through its course without any deviation from its usual habits; and, notwithstanding this, the cow-pock virus excited its common appearances, both on the arm and on the constitution, without any sensible interruption; on the sixth day there was a vesicle.

"8th. Pain in the axilla, chilly, and affected with head-ache.

"9th. Nearly well.

"12th. The pustule spread to the size of a large split pea, but without any surrounding efflorescence. It soon afterwards scabbed, and the boy recovered his general health rapidly. But it should be observed, that, before it scabbed, the efflorescence, which had suffered a temporary suspension, advanced in the usual manner.

"Here we see a deviation from the ordinary habits of the small-pox; as it has been observed, that the presence of the measles suspends the action of variolous matter. However, the suspension of the efflorescence is worthy of observation.

"The case of co-existence of the cow-pox and the chicken-pox, which occurred to Mr. Little, of Plymouth, is published by Mr. Dunning, in his Observations on Vaccination. In that case the chicken-pock appeared on the tenth day of vaccine inoculation. The vaccine pustule was at that time arrived at its height of inflammation, and maintained its specific character."

A most remarkable case occurred to me. A girl, aged about nine, living with the dowager the countess of C——, fell from the balustrade of the stair-case, from the height of above forty feet, and pitched on her skull on the stone landing-place. The fracture was extensive, and the largest piece of bone ever remembered was taken away by Mr. Heaviside, which is to be seen in his invaluable museum. A silver plate now defends the brain. This child was cautiously watched,

watched, in order that she might not catch the natural small-pox; and Dr. Turton and Mr. Heaviside were justly apprehensive of inoculation. Their good sense at once, however, coincided that she should be inoculated by me with *vaccine matter*, and she passed through the disease without one day's illness, with only the slight inconvenience of the pustule on the arm.

5. *Pregnancy.*—"I have inoculated," says Dr. Marshall, "a great number of females at different periods of pregnancy, and never observed their cases to differ in any respect from those of my other patients. Indeed the disease is so mild, that it seems as if it might at all times be communicated with the most perfect safety *." The same success is recorded by Henry Jenner, who relates a case, where he inoculated a person a week previous to the accouchement †.

6. *Old age* no exception.—For confirmation of the truth of his position, I shall give the report of the committee of vaccine inoculation ‡ at Paris, instituted by order of government.

"Report. The vaccine affection appears to us to be of a nature the most benign, and which hardly deserves to be called a malady: not so much as one accident occurred to the hundred and fifty subjects who have been inoculated.

"The vaccine inoculation is no less practicable than exempt from accidents, *whatever be the age of the persons* on whom it is performed. Infants have been inoculated in the arms of their nurses; others at the age of one, two, and three years to fifteen. Persons of the age of forty, and even fifty to *seventy* years, have also been inoculated, and always with the same success."

Lastly, the cow-pock does not leave any bad humours after it.

The small-pox has been justly accused of often leaving the body in that state of wretched debility, as to make life afterwards only a continued series of excruciating affliction. Besides other horrid disfigurations of the person, *scrophula*, or the king's evil, not unfrequently follows the natural or

* From Jenner's Inquiry, p. 161., second edition.

† Vide Jenner's Inquiry, p. 174.

‡ The most distinguished physicians at Paris were selected for this purpose; as, Thouret, director of the school of medicine; Pinel, professor of physic in the school of medicine; Leroux, clinical professor; Parfait, inspector of the military hospitals, &c. &c.

inoculated

inoculated small-pox. The insertion of the humour of a brute into the human body in *vulgar* conception led *à priori* to the expectation of a loathsome distemper. But fortunately for the human race a more benign disease than the small-pox was the consequence, and one only similar to it, in having a somewhat resembling pustule, and in the property, of ever after securing from that fatal and loathsome distemper.

"Every practitioner in medicine," says Dr. Jenner, "who has extensively inoculated with the small-pox, or has attended many of those who have had the distemper in the natural way, must acknowledge that he has frequently seen scrophulous affections, in some form or another, sometimes rather quickly showing themselves after the recovery of the patients. Conceiving this fact to be admitted, as I presume it must be by all who have carefully attended to the subject, may I not ask, whether it does not appear probable that the general introduction of the small-pox into Europe has not been among the least conducive means in exciting that formidable foe to health? Having attentively watched the effects of the cow-pox in this respect, I am happy in being able to declare, that the disease does not appear to have the least tendency to produce this destructive malady."

To this authority of Dr. Jenner we may add the following from the evidence delivered before the committee of the house of commons:

Dr. Nelson, physician to the Vaccine Institution, declares, that he had never observed any disease to have been *excited* by the vaccine inoculation: *on the contrary,* the health of sickly children was in general much mended by it.

Dr. Baillie declares, he has not known an instance in which the vaccine inoculation had *introduced* or *excited* any disease; but he had known instances of the absorbent glands becoming enlarged and scrophulous, soon after a patient had undergone the small-pox: these instances happen sufficiently often to make a general impression upon the minds of medical men, that the constitution was sometimes excited to form scrophula, in consequence of the irritation that it had previously undergone during the small-pox.

Dr. James Sims, president of the Medical Society of London, gave it as his opinion, that the vaccine disease does not introduce any other disorder into the human frame.

Mr. Cline, surgeon, lecturer on anatomy, states, that he believes

believes that the cow-pock does not excite scrophula, or any other disease, which is sometimes the case with the inoculated small-pox.

Mr. James Simpson, surgeon to the Surry dispensary, and to the Magdalen hospital, has practised vaccine inoculation, and has inoculated between fifty and sixty patients, and in no one instance had any symptoms occurred injurious to the part inoculated, or constitution of the patients; and he believes them to be completely secure from the small-pox. In one particular instance, the patient, a child of nine months, was covered with a crust commonly called the *crusta lactea,* which generally covers the body from head to foot, and had resisted the usual remedies for that disease: but on the tenth day after the infection it began to *disappear,* and on the twelfth day was wholly gone; during which time not a particle of medicine was given to it, and it continued in perfect health ever since.

Dr. Willan, who practised the cow-pock in the absence of Dr. Woodville on a large scale, who is more conversant with every species of eruptive diseases than any other practitioner, I believe, in Europe, relates in his reports of the diseases of London.

"The vaccine disease has not, in any case I have seen, been attended with glandular swellings, ulcers, cutaneous affections, diseases of the lungs, puffy tumours of soft parts, enlargement of bones, ophthalmia, deafness, dyspnœa, anasarca, hydrothorax, which so often occur after the small-pox, whether produced by contagion or inoculation. This circumstance alone would cast the balance in favour of the cow-pock, even were this disease on a level in some other respects with the small-pox."

Its security as a prophylactic against the small-pox has been before considered.

XLIII. *Eighteenth*

XLIII. *Eighteenth Communication from Dr. Thornton, relative to Pneumatic Medicine.*

To Mr. Tilloch.

Dec. 15, 1804,
DEAR SIR, No. 1, Hinde-street, Manchester-square.

In order to show the superior advantages of any remedy, it is necessary to state cases in which the common means have failed under the ablest practitioners; and this will plead my excuse for generally naming the parties concerned; for, having no other purpose in view but to spread a knowledge of *pneumatic medicine*, I have related usually both the names of the patients cured, and under what physician's care these were previous to their applying to me, but without ever intending thereby to derogate aught from their well-known skill. The following case is a very striking one in favour of *pneumatic medicine:*

Case of an Affection of the Heart.

Mr. Mortlock, aged 26, who keeps the large Colebrook Dale China warehouse, No. 250, Oxford-street, when I first attended him, had been *nine months* ill. His disease was "a continual gnawing, uneasy pain" in the chest; I suppose it to arise from the heart, his interrupted pulse appeared to indicate this, so that life was insupportable: the pain was so acute, upon using the slightest exercise, that he could not get up a flight of stairs without resting, and he could even hardly walk across the room. So increased was this pain, also, upon taking any food, that he was obliged to desist from all animal food, wine, or beer, and lived wholly on garden stuff, and drank water. His spirits partook of his general inability; there was no intermission to his pain night or day. He first was under the care of Mr. Chevalier, a surgeon distinguished for his treatise on gun-shot wounds, which obtained for him a diamond ring from the present emperor of Russia; who, after trying various remedies, recommended a physician, Dr. Pitcairn, who was consulted; and leeches to the chest, with blisters, and then tonics, were used, but all to no manner of purpose; he began to despair of ever being cured; when the duchess of Bolton, and the countess of Lonsdale, urged him by all means to consult me. Lady Mount-Edgcumbe pressed him in

in the same manner, with several others of the nobility; and, from obedience rather than *faith*, he put himself under my direction. I shall be brief in my narrative;—employing the same strengthening remedies that Mr. Chevalier was then judiciously using, I ordered, in addition, the inhalation of a gallon of *vital air*, mixed with three of atmospheric, once a day, and the pain gradually abated from the very first trial of the air, and wholly disappeared in the course of a fortnight, and at the end of three weeks he was the most altered person in the world, being then in the full enjoyment of health.

Observations on this Case.

1. The effect of the inhalation of a gallon of *vital air*, deluted as above, was a kind of *intoxication*, which lasted for five minutes; he could stand upright, but felt, he says, "as one under the impression of liquor, all objects appearing confused to him, and in motion." This was not succeeded by head-ache.

2. This intoxication was produced for a week, but diminished in degree after each successive inhalation; afterwards no such effect was observed.

3. Only a sensible increase of warmth.

4. His appetite, which was before wholly lost, recurred.

5. Now he eats whatever comes to table, and takes his beer and wine as others.

6. He walks now often three miles at a stretch, without feeling any distress or fatigue.

7. His pulse is regular and good.

8. The benefit, as yet, has continued more than three months, and, I trust, will be permanent.

9. The question is, whether so quick a change in such a disease could have been accomplished by the use of *medicine alone?* or *vital air alone?*

10. Or whether the *vital air*, by stimulating the heart, did not impart, aided by *proper medicines*, some change to that organ, and thence produce the whole train of benefits.

I have the pleasure to sign myself,

Dear sir, your obliged, devoted friend,

ROBERT JOHN THORNTON.

XLIV. *Nineteenth Communication from Dr. Thornton relative to Pneumatic Medicine.*

To Mr. Tilloch.

Dec. 20, 1804,
No. 1, Hinde-street, Manchester-square.

Case of Defective Circulation.

Mary Stafford, aged thirty, servant to Mrs. Mills, No. 16, Queen Ann-street, west, was subject to have her fingers swelled in both hands, looking blue, and so stiff as to incapacitate her from doing any kind of needle-work; she could not clench her hand. This disease, if I may so call it, occurred every winter, and various external remedies were used, but still it remained always throughout the winter. This lady having observed this affliction in her maid, a valuable servant, for five years, the time she has lived with her, Mrs. Mills wished her to consult me about the *vital air*. In consequence, I advised the inhalation of the *vital air*, a gallon per diem, diluted with three of atmospheric; and at the end of a week, the swelling, blueness, and tension of the fingers, went off, and she obtained the perfect use of her fingers, and is able to do any kind of needle-work, even during this hard frost; a circumstance she cannot remember in any former winter, and she ascribes the benefit received from the inhalation of the vital air.

Observations on this Case.

1. Mrs. Wilkinson, whose remarkable cure I have recorded in my Philosophy of Medicine, had *whitlows* frequently during the time of her inhaling of *vital air*, and was never subject to them before or since, which, together with the present case, evinces that the blood, by the *vital air*, is powerfully determined from the heart to the extremities.

2. Governor Pownall mentions, in a letter to me, that he knew a manufacturer who was accustomed, once a day, to give to his workmen, obliged to be confined in the vitiated air of a crowded room, after work, diluted *vital air*, and thereby preserved them both in health and spirits. He makes this query—Have we in nature a more useful *cordial* than the vital air? other *cordials*, as they are called, *indirectly* accelerate the motion of the heart, this *mediately*, and without injuring in the least the tone of the stomach.

3. When inhaling the *vital air* for other diseases, chilblains have ceased in winter to appear.

XLV. *Me-*

XLV. *Memoir on the Devitrification of Glass, and the Phænomena which take place during its Crystallization.* By Dartigues*: *Read in the Physical Class of the Institute, May 20th,* 1804 †.

Some chemists have considered glass as a crystallization: this opinion appears to be natural, in consequence of the transparency of glass or crystal, since we have borrowed the name of the latter to denote a regular and spontaneous arrangement of the moleculæ of bodies; but, on a little reflection, we discover our error: glass, indeed, never affects the crystalline form, either at its surface or on its fracture; it never exhibits crystals of its own substance, as is remarked in certain metals properly cooled; and if crystals are formed in the mass of glass, they are foreign to the part still vitrified; they may be considered as a retrograde step of vitrification; this I shall prove in the course of the present memoir.

Beginning with a definition of vitreous fusion, I shall distinguish and separate that of bodies fusible by themselves in the fire of our furnaces; such as borax, phosphoric and other acids. Here caloric, being condensed, softens and fuses the substances, which retain more or less, after they have cooled, transparency and the other physical properties of glass, with which every body is acquainted.

But I ought to examine and describe that fusion experienced by the vitreous compositions employed in the common purposes of life: in the latter case, vitrification is the result of a double phænomenon; it is not only the effect of caloric accumulated, but it is produced also by the affinity of the substances which enter into the mixture. Those substance which tend to combine and to penetrate each other, exercise the laws of their affinity the moment they have attained to a sufficient temperature. It is thus that several earths, when united, fuse at a degree of heat at which each of them separately would not have changed its state.

Thus common vitrification, among different and hetero-

* Dartigues, proprietor of glass manufactories and other establishments at Vonêche, (Sambre-et-Meuse) engaged to submit to the institute a treatise on the art of *glass-making*, to serve as a continuation of the *Arts and Metiers* of the academy. The first part is ready for publication; a great many of the plates are engraved. The second part contains the application of glass in the different arts in which it is employed. The third part consists of detached memoirs on the physical and chemical properties of glass. The present dissertation is an extract from one of these memoirs.

† From *Annales de Chimie*, No. 150.

 geneous

geneous substances, is the result of a combination made at a high temperature; a result which exhibits a compound perfectly homogeneous, more or less transparent, elastic, breaking in a particular manner, whence comes the name *vitreous fracture*; a body a very bad conductor of caloric and electricity, and susceptible of becoming soft at a temperature inferior to that at which it was fused, of becoming paste-like, ductile, &c.

The phænomenon, during which all these properties disappear, is what I call *devitrification:* this expression may at first appear extraordinary, but it will be seen that it is perfectly just.

Devitrification has already been observed by various chemists; some even have seen and remarked several circumstances, but in an insulated manner; and I do not know that any one has ever published a complete body of researches proper for rendering it clear, and for proving that it is connected with all the known properties of all bodies of nature, and that it is only the product of crystallization.

Reaumur first observed that glass, especially when composed of different earths, as bottle-glass is in general, may be decomposed, and lose its transparency and all its other vitreous properties. Being entirely engaged with his labour on porcelain, he was desirous of applying this discovery to the fabrication of pottery, and ascribed the phænomenon to the substances in which he caused glass to cement. This fact is called *cementation of glass*, and the result, Reaumur's porcelain. Nothing was more calculated to retard the real knowledge of this phænomenon than a similar denomination.

The labours of Bosq d'Antic, on the same object, were undertaken merely to obtain by this method a good kind of pottery, and to find cements by the help of which new properties might be given to that body. It is thus that, by giving the improper name of *cementation* to a phænomenon which depended in no manner on the substances added as cement, they misled those who were induced to follow the course of the experiments before made. It indeed results, that science has gained nothing in this respect since the time of Reaumur; several persons have attempted to cement glass, and observed nothing more in the result.

Several persons have since observed in glass the property of giving birth to crystallization; those remarks, made in particular by artists placed at the head of glass manufactories, have not furnished the consequences which ought to be deduced. The heads of a large establishment have seldom

time to stop to contemplate small effects; they are obliged to embrace too many things at once. These remarks, curious in themselves, remained without any consequence; and no one imagined, or dared to publish, that the crystallization of glass and cementation, by the process of Reaumur, were absolutely one and the same.

Sir James Hall, in his ingenious experiments on whinstone and lava*, discovered in these stones the property of fusing into glass, and of returning to the state of stones, according to circumstances.

He calls the latter fact a devitrification; he saw that it was the effect of a precipitation, and he explains it in a true and satisfactory manner; but being too much occupied in deducing from this fact arguments in favour of the volcanists, he neglected to follow in that phænomenon whatever interesting it presented to the philosopher. This is the task which I have imposed upon myself; and, in this memoir on devitrification, I propose to explain the result of my last researches; as my situation has placed at my command a fire exceedingly violent, and continued for several years, I was enabled to observe what few have an opportunity of seeing. The facts which I am going to relate partly explain themselves; they are the result of the laws to which all bodies are subject; the whole merit of the observation consists in having seen them in substances in which, and at times when, it was not known that these laws took place.

The bottom of furnaces for fusing glass exhibit in general large cavities, hollowed out by the action of the fire and of corroding substances, which often fuse crucibles. These cavities become filled with a kind of glass called *picadil.* This picadil is the result of the ashes, which are vitrified, of some of the stones of the furnace which are fused, and particularly of the glass which falls from the pots. Care is taken to take it out at each fusion. At the end of the duration of the furnace, the fossæ, being enlarged, cannot empty themselves entirely, and on that account *picadil* remains in them. When the furnace is extinguished, the picadil experiences a cooling exceedingly slow, because it is surrounded by mason-work, consisting of several cubic toises, which has been heated for more than a year. I always observed that it was in the glass at the bottom of the furnaces that I found crystallizations; they were diffused throughout the mass of the glass, which, in other respects, was exceedingly

* *Bibliothèque Britannique,* vol. xiv. See also the Philosophical Transactions.

pure and transparent. These crystallizations, always numerous and very regular, excited my curiosity, as they had done that of several glass manufacturers before. I collected a large quantity of them; and I carefully selected the most curious, and those which exhibited the most extraordinary characters.

By comparing the pieces I had obtained, and the circumstances under which they were produced, and by making remarks, attempts, and experiments to imitate at pleasure these crystallizations, I was soon able to distinguish different classes of them, all produced by the nature of the different substances which enter into the composition of glass. I shall here take a short view of them: I shall not, however, speak of devitrification, which almost always takes place in the scoriæ of forges; every body has been able to remark it, and may account for it by what I am about to say.

The first remark which may be made is, that the more ingredients there are in glass, the more susceptible it is of being speedily and easily devitrified: but as a solvent charged with a great quantity of saline substances suffers them to crystallize in a more confused manner, it is also not in these kinds of glass that the most regular crystallizations are remarked; a precipitation is effected in the whole mass; each of the ingredients obeys, at the same time, the laws of affinity: transparency disappears speedily, and in a little time nothing more is perceived than a stone instead of a vitreous body. Amidst this chaos, it is however impossible not to discover the rudiments of crystallization. Such are the phænomena exhibited in their devitrification by glass bottles, which approach near to glass entirely earthy, since very few salts enter into their composition.

Any person may keep a common glass bottle in a heat long enough continued, and capable of softening its paste; soon after it changes its colour, becomes gray, and has the appearance of earthen ware. Such is the porcelain of Reaumur; but it is seen that there is nothing here which has the least resemblance to cementation.

Now, instead of observing the phænomenon in so small a mass, if I search the bottom of the furnaces in which such bottles are fused, I find that the glass is absolutely devitrified, and that it even has assumed so stony an appearance, that the most expert eye can scarcely distinguish the brick of which the furnace is constructed from the part which has been glass. It is only by following, in the fragments less advanced, the progress of the devitrification, that one can distinguish the glass in a granulated stone, which has

rather

rather the appearance of earthen-ware, or strongly baked clay.

Cooling, continued for an hour or two, is often sufficient to effect an entire devitrification of the glass of bottles. I have pieces about eight centimetres in thickness, which I collected in the glasshouse of M. Saget, at La Gare. On taking from the furnace a pot intended to be renewed, the glass which remained at the bottom was preserved from cooling during the time employed by the pot in cooling: and the nature of this glass was entirely changed; it was nothing but a mass of crystals composed of small needles converging towards common centres. There was no longer any appearance of vitrification.

This fact shows with what facility the glass of bottles becomes vitrified, and always without the least appearance of cementation.

The infinite variety of the substances employed in making bottles produces a great change in the phænomena which take place during their devitrification, and no doubt must have an influence on the form of the crystals; but I have not had much opportunity of observing this kind of glass.

Proceeding then to glass less earthy, and composed of fewer substances,—if I examine also the bottom of furnaces for fusing that kind of glass called glass of Alsace, or half white glass, in which there is more pure silex, and more alkali to fuse it, I observe nearly the same phænomena, but, being less abrupt, they are more easily remarked and separated. At first, and in pieces where devitrification is commencing, people might almost say that they saw a blue colour diffused throughout a greenish liquid.

I shall here briefly mention a very singular fact, which I intend to examine at more length in another memoir. This greenish glass mixed with blue seems, indeed, to have become of a dirty blue when looked at opposite to the light; but if it be placed between the light and the eye, it seems always greenish, so that it reflects the blue, and only refracts the greenish colour. Continuing to observe the devitrification of demi-white glass, it is seen that the blue precipitation is followed by another more abundant, which gives the dirty white, and is very distinct from the former. The latter becomes still darker and darker, till it at length assumes the colour of gray horn.

In these different transitions the paste of the glass seems always to exist. One may distinguish its polish, its fracture, and all its other properties except transparency: but in the midst of this paste similar to horn, very distinct cry-

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stallizations are formed; these are nuclei composed of small needles all converging towards the centre. In this state it is no longer glass; it is crystal, which possesses all the physical properties of mineral substances left to themselves.

An exact analysis, made with a certain number of crystals carefully detached from the mass, would indicate their nature, and throw more light on their formation.

It often happens that these crystallized nuclei are enveloped with a crust which seems foreign to their nature, and which may be compared to the crust with which flints are covered in the banks of chalk, where they seem to grow.

Such is the series of the phænomena exhibited by the devitrification of demi-white glass when it takes place slowly; but if hastened too much, these phænomena return to the class of those which may be observed in glass bottles. The common glass in question was that in which no earthy substances but wood ashes were employed. There ought, therefore, to be infinite varieties in it, according to the different compositions.

It is very difficult to make white glass crystallize or to become devitrified. When well made one may even say that it is not altered by heat a long time continued; but that this may be the case there must be nothing in its composition except silex, and only the quantity of flux necessary to saturate it. A heat continued as long as possible will not then effect any other change in the glass than to harden it and make it become yellow.

When white glass contains a certain quantity of neutral salts or glass gall, which the fire has not had time or power to dissipate, there often results during a slow cooling what is called *graisse*, *ratine*, bubbles, and stones, which re suddenly and spontaneously formed.

These accidents, their different causes, and the remedies to be applied, are treated of at full length in the first part of my work, where I speak of the fusion of glass; but, though the explanation of these facts belong entirely to the theory of devitrification, I think it necessary to treat here of the phænomena arising from the presence of the different earths.

White glass contains lime in greater or less quantity, in consequence of the reasons mentioned in speaking of the different compositions of this substance. This lime, when in excess, crystallizes exceedingly well, as remarked by Loysel. These crystals may be easily distinguished: they are so abundant that they absolutely obscure the transparency. They are prisms which seem to float in the midst of

of the paste of the glass, and which tend to collect themselves into stars of different forms. These stars are all nearly of the same size, and about two or three millimetres in length. When this crystallization is effected of itself in large masses at the bottom of the furnaces, the colour of the glass becomes darker, inclining to black, by the presence of a certain quantity of ashes mixed with it. The striated stars here mentioned become the more numerous as they recede further from the side in contact with the fire. Crystallizations first insulated are soon succeeded by a mass entirely crystallized, in which nothing of the vitreous character is distinguished.

Such are the most usual characters of crystallization; but one often sees others which are certainly owing to chance, and which deserve to be observed on account of their variety *.

I have some pieces of glass containing crystals of so great tenuity that they can scarcely be seen by the help of a magnifying glass. They are prisms diverging from the same centre and forming stars which are often not more than a millimetre in size: their union seems to be a slight obscurity in the paste of the glass.

Some pieces exhibit the aspect of a saline crust applied on a foreign body with which the glass was in contact. In some, this crust, composed of striated paps, seems to advance more and more, and to gain on the glass.

There is still another variety more curious than any of those already mentioned; it is that observed in the middle of the paste of the glass; centres of crystallization like peas, and almost similar to grains. They are small globules flattened at the two ends, with an umbilicus in the middle of each depression. The sides have ribs like the seeds of the capucin, and these ribs are always six in number.

My intention is, when I can procure a sufficient number of these singular crystals, to analyse them, in order to discover what is the earth which affects so extraordinary a form.

Such, in a few words, are the principal facts by which the precipitation and crystallization of glass are characterized. It is seen that they are of the same nature as those produced by the cementation indicated by Reaumur, and that the result is always a devitrification more or less absolute.

* M. Sage has in his possession a piece of glass crystallized into basaltic prisms of six planes and entirely devitrified.

When

When glass is devitrified it has no longer a vitreous but a granulated fracture: it possesses no transparency, and has a perfect resemblance to a stone: it becomes a less bad conductor of caloric and electricity. In a word, it is no longer susceptible of being fused at the same degree of heat; and, to bring it more easily to the vitreous state, it must be first pounded, in order to place in contact the substances which were separated from each other during the crystallization, and which can no longer serve as mutual fluxes.

I wish the novelty of several of the facts which I have here related, and the consequences I have deduced from them, in proving that the crystallization of glass is a devitrification, may be sufficiently interesting to induce chemists to pay attention to them. I have no doubt they will be able to form many comparisons which escaped me, or which the limits of a single memoir would not allow me to mention. The resemblance of my specimens of devitrified glass to those of certain kinds of lava; the possibility that other kinds of lava may have undergone a more absolute devitrification by a longer cooling through volcanic currents, or by remaining fluid for whole years under crusts already cooled: every thing, in short, induces me to believe that these facts may afford the means of explaining geological phænomena respecting which philosophers have not agreed, because nothing could make them believe that stones had before been glass.

XLVI. *On the beautiful Green Colour for Painting, which may be obtained from Chrome.* By GODON-SAINT-MEMIN*.

When M. Vauquelin made known his ingenious labour on the red lead of Siberia, as the interesting series of the analyses which he published showed him that chrome is dispersed throughout various parts of the earth; since America presents it in the emerald, India in the spinel, and Siberia in chromatized lead; he foresaw that this metal would one day be found in a natural state sufficiently abundant to make a useful application of it to the arts, and he indicated the importance of it in a memoir †. The discovery of chromatized lead ore found in France confirmed the happy conjectures of this illustrious chemist, and convinced us that the

* From *Annales du Muséum National d'Histoire Naturelle*, No. 21.
† *Annales de Chimie*, Fevr. 1798.

the knowledge of chrome was a present of great value made to the sciences and to society.

Being employed at present in examining the chemical properties of this metal, I directed my observations in particular to its oxide, or the combinations it may present with earths, in the hope of finding the elementary green colour so long wished for by painters. A series of experiments enabled me to publish results so very satisfactory, that I hope soon to see the green colour of chrome make a figure on the pallette of the painter along with those beautiful colours for which the art has long been indebted to those occupied with the natural sciences.

Having prepared, by the common processes, an alkaline chromate, I poured into it a solution of mercury *ad minimum*. There was formed a precipitate of a very beautiful red colour, which experienced no sensible change in the air. As this chromate exhibited a combination very proper for furnishing oxide of chrome by an easy decomposition, I thought that this salt mixed with an earth would give, by the aid of heat, the colour I required.

Three parts of the chromate of mercury and one of alumine were strongly heated in a crucible. The result was a yellow substance, slightly greenish at the parts in contact with the air, and which I found to be chromate of alumine.

I repeated the same experiment with the same proportions, but in a stronger heat, and obtained a beautiful green colour having a great deal of body, which experienced no alteration either from the air or from light. The series of my experiments naturally induced me to analyse the chromate of mercury, the result of which I shall here lay before the reader, as it may serve to guide those who may be desirous of procuring oxide of chrome, or the green colour proper for painting.

Analysis of the Chromate of Mercury.

Fifty grammes of the chromate of mercury were introduced into a retort, to the neck of which was adapted a glass tube immersed in a tub, a flask being properly placed to collect the gas which might be disengaged during the operation.

After being exposed for fifty minutes to a heat which, during the last moments, was exceedingly strong, I thought that the whole of the mercury must have passed over. I took the apparatus from the fire. The whole of the mercury condensed in the tub was found to amount to 40 grammes. I found the chrome oxidated under the form of a light regulus

gulus of a green colour, exceedingly intense, the weight of which amounted to no more than 06·3.

The neck of the retort was slightly lined with some small portions of green oxide, and of a substance of a darker red than that of chromate of mercury, but which I suppose to be, with some modifications, the same combination.

I have not yet determined the weight of the oxygen gas, but it may be easily seen that the defect 03·7 minus the quantity of oxygen which constitutes the oxide of mercury at a *minimum*, expresses nearly the difference which exists between the state of oxidation and that of the acidity of chrome.

This oxide alone, by its mixture with the carbonate of lead (white lead), furnishes durable and varied tints; but it is no doubt more advantageous to employ it in the state of combination with an earth; for it appears certain that in this circumstance the colours of the metallic oxides acquire more brilliancy and durability, as we find to be the case in ultramarine, smalt, sienna, earth, &c.

The green of chrome, besides the advantage of being useful in painting in oil and distemper, may, with the necessary quantity of flux, be applied immediately on porcelain, and can endure the greatest heat without alteration. It may be employed for painting on glass, in enamel, and for communicating to crystal the colour of the most beautiful emerald. It may be used in general for ornamenting pottery of all kinds. I have found by experiment that it may be prepared at such a price as to be within the reach of all manufacturers. The different essays I had had the honour to submit to administration seem to me sufficient to induce me to believe that this colour will one day furnish a great resource to our manufactories.

I propose to make known other observations proper to enlarge the history of chrome, as well as of some preparations, which, perhaps, as well as artificial chromate of lead, already introduced into painting, may become interesting to the arts; but I wish to have leisure to present in order the notes I may be enabled to make on this substance, of more importance to be studied, as the territory of France seems to furnish it in abundance.

Result of the Analysis of the Chromate of Mercury.

Oxide of chrome	12·6
Oxide of mercury	83·
Difference between the state of oxidation and that of the acidity of chrome	4·4
	100·0

XLVII. *Re-*

XLVII. *Reflections on the particular Properties of Roman Alum. By* M. Curaudeau, *Member of the Society of Pharmacy at Paris, &c.**

M. Vauquelin has recently analysed the different kinds of alum employed in commerce, and from this analysis has shown that the proportions of the acid and of base are nearly the same in each kind.

M. Hassenfratz observes †, that if Vauquelin finds no sensible difference in the proportions of the acid and bases of each kind of alum, it is however very true that dyers allow that Roman alum produces in dyeing, effects which could not be obtained from the other kinds. The same chemist adds, that if any other person than Vauquelin had announced this result he should have been inclined to suspend his opinion; but that chemists have assured themselves of the exactness of M. Vauquelin, and the confidence to which his experiments are entitled. This opinion, in which I sincerely participate, is still strengthened by the labour I have been engaged in on alum.

M. Hassenfratz, however, cannot resist the doubt excited by the difference in the crystallization of Roman alum, which affects the cubic form, and of the other alums the form of which is octaëdral. He suspects that this difference may depend on the quantity of the base which Roman alum may have greater than the other kinds of alum, though, like them, it may have an excess of acid.

This observation of M. Hassenfratz on the difference of crystallization is very correct; but, as the consequence which he deduces can be only conjecture, it can in no manner stand in opposition to the analysis of Vauquelin. In regard to the preference given by the dyers to Roman alum, it is not the result of an ill founded prejudice; it is certainly true that Roman alum produces in dyeing, effects which cannot be obtained from the other kinds of alum. I have prepared with Roman alum red morocco as beautiful as that of Choisy, while with any other kind of alum I could obtain only disagreeable colours.

Crystals of Roman alum obtained in a liquor with excess of sulphuric acid, retained in dyeing the same properties as they had before their solution.

This experiment, which destroys the conjecture of M. Hassenfratz in regard to the excess of base in Roman alum, proves that this alum has properties peculiar to it, but which cannot be explained by analysis. Unfortunately,

* From *Annales de Chimie*, No 153.
† *Annales de Chimie*, No. 150.

there

there are many of these phænomena of which chemists will long remain spectators before any cause can be assigned for them.

How can we explain the phænomena of cementation, which converts into steel one of the extremities or the middle of a bar of iron subjected to this operation, while, *cæteris paribus*, the remainder continues to be iron?

How can we explain the phænomena of the combination of hydrogen with oxygen, which, instead of giving birth to an acid liquor, produces an insipid liquor?

From the analysis of M. Vauquelin one might suspect the observation of M. Hassenfratz, and the experiment I have mentioned, that the properties of Roman alum depend on the state in which the alumine is found, and that there must be a great difference between the alumine of Roman alum and that of our natural or artificial alums.

A volcano has been the crucible in which nature prepared the Roman alum, while our furnaces, in which we prepare that alumine, though brought to a strong red heat, are cold in comparison of the conflagration produced by a volcano*. How much colder are the turfy marshes in which the latter alum is prepared by nature? Every thing then proves that the action of the caloric must have been very strong, and that it is by it that a very particular modification has been brought to the state of alum. This conjecture is still further strengthened by another phænomenon—that exhibited by the presence of potash in the earths of solfaterra. This alkali has certainly not had there a vegetable origin, and under this circumstance it cannot be considered but as the result of a combination of the principles which the heat may have called into action in some mineral substances.

I shall conclude by observing, that the accuracy of M. Vauquelin's analysis ought to subsist, because analysis cannot follow these modifications, and that alumine, when it issues by analytical means from its composition of Roman alum, cannot appear to us but in that new state of modification given to it by the re-agent in taking it from its first composition. I presume that this explanation will long be the only probable one that can be given in regard to the causes of the particular properties of Roman alum, and that further researches on this subject may have a great resemblance to those the object of which is to discover the philosopher's stone.

* If this opinion of the author be correct, how are we to account for mineral substances being found unfused in volcanic scoria which would not resist the action of our furnaces?—EDIT.

XLVIII. *List*

XLVIII. *List of Patents for new Inventions which have passed the Signet Office from November 24 to December 24*, 1804.

To Thomas Margrave, of the parish of St. Mary, White-chapel, in the county of Middlesex, silk throwster, for the sole use, benefit, and advantage, of his invention of certain mills and machinery, upon a new or improved construction, for throwing, spinning, doubling, and twisting silk thread, cotton thread, flax thread, hemp thread, and all such other articles as usually are or may be thrown, spun, doubled, or twisted.

To Samuel Guppy, of the city of Bristol, merchant, for his invention of certain additions and improvements on machines for cutting, heading, and finishing nails, and the mode of working thereof, for which machines he obtained his majesty's letters patent, bearing date on or about the 19th of August 1796, whereby considerable labour is saved, and which additions and improvements may be used with, or independent of, such former machines.

To Richard Willcox, of the city of Westminster, engineer, for certain machinery for more expeditiously cutting, stripping, or plucking the various furs of beavers, seals, wool, hair, &c. from the various skins now cut, plucked, or stripped by hand, and for sundry methods of preparing and cleansing the said skins.

To Stephen Pasquier, of Wilderness-row, Charterhouse-square, in the county of Middlesex, professor of languages, for a new manufacture, system, or method of writing, printing, engraving, drawing, painting or stamping, working and using certain characters, figures, instruments and machines for facilitating correspondence and other literary operations.—This patent extends to all his majesty's colonies and plantations abroad.

To Joseph Wickham Mayer, of Soho-square, in the county of Middlesex, esq., for certain improvements on bits of bridles.

To Abraham Underdown, of the parish of Ealing, in the county of Southampton, for a new mode or method of making flour without grain.

To Solomon Hougham, of Aldersgate-street, in the city of London, goldsmith, for spring clasps for buckles, lockets, and other ornaments of dress.

To

To William Everhard, baron Van Doornik, of Well-street, in the county of Middlesex, for certain compositions formed by uniting an absorbent or detergent earth with other ingredients, so as to render the same more effectual in washing or scouring, and for various purposes, to which soaps and detergent earths are now applied.

XLIX. *Description of a Woulf's Apparatus, invented by Mr.* J. KNIGHT, *of Foster-lane, London*.*

THE inconvenience attending the complicated form of the Woulf's apparatus now in use, is felt by experimental chemists in general. Considering, therefore, how desirable a thing it would be to render so useful an apparatus more simple, and at the same time preserve all its properties, I have endeavoured to accomplish it by constructing an apparatus agreeably to the following description. How far I have succeeded in my object, the public will be able to judge; and should it prove useful I shall feel gratified in having contributed to the advancement of science.

AAA (Plate VII.) represents three vessels, each ground into the mouth of that below it.

BBB, glass tubes, the middles of which are ground into the neck of each vessel, which allows the upper end to rise above the liquor, while the lower descends nearly to the bottom of the next vessel below. The upper vessel serves as the receiver to catch whatever may come over in a fluid form.

E, a Welter's tube of safety, to prevent absorption.

D, the lowest vessel, has a foot which supports the whole apparatus. The tube C is for the purpose of conducting the gas into a pneumatic trough.

F, an adapter ground to fit the receiver, to which any retort may be joined and luted before the latter is put into its place.

In order to prevent the danger of oversetting the apparatus I place it on a square wooden foot, to which the glass one is easily fixed by sliding it in between two grooves.

By substituting a stopper in place of the adapter this apparatus forms a very complete Nooth's; the materials being put into the receiver at top.

* Communicated by the Inventor.

L. Pro-

L. *Proceedings of Learned and Economical Societies.*

ROYAL SOCIETY OF LONDON.

On Friday the 30th of November, being Saint Andrew's day, the Royal Society held their anniversary meeting at their apartments in Somerset Place, when the president, the right honourable sir Joseph Banks, bart. K.B., in the name of the Society, presented the gold medal (called sir Godfrey Copley's) to Smithson Tennant, esq. for his various chemical discoveries communicated to the Society, and printed in several volumes of the Philosophical Transactions. The president delivered the customary discourse on the subjects contained in Mr. Tennant's papers. Afterwards the Society proceeded to the choice of the council and officers for the ensuing year, when, on examining the ballots, it appeared that the following gentlemen were elected of the council:

Of the old council,—The right honourable sir Joseph Banks, bart. K. B.; sir Charles Blagden, knt.; Henry Cavendish, esq.; Edward Whitaker Gray, M. D.; right honourable Charles Greville; Charles Hatchett, esq.; William Marsden, esq.; Rev. Nevil Maskelyne, D.D.; George earl of Morton; Joseph Planta esq.; John Walker, esq.

Of the new council,—The right honourable lord Frederic Campbell; Davies Giddy, esq.; William Herschel, LL.D.; George earl of Macartney; William Parsons, esq.; James Robertson Barclay, M.D.; Samuel Horsley, lord bishop of St. Asaph; Rev. Richard Dickson Shackleford, D.D.; William Hyde Wollaston, Esq.; Henry Penruddocke Wyndham, esq.

And the officers were,—The right honourable sir Joseph Banks, bart. K.B. president; William Marsden, esq. treasurer; Edward Whitaker Gray, M.D.; William Hyde Wollaston, esq. secretaries.

Afterwards the members of the Society dined together, as usual, at the Crown and Anchor Tavern, in the Strand.

ROYAL ACADEMY.

On Monday, Dec. 10th, being the anniversary of the institution of the Royal Academy, a general assembly was held for the appointment of the annual officers for the year 1805, when

Benjamin West, esq. was re-elected president. Henry Thomson, Philip James de Loutherbourg, Robert Smirke, Joseph Farington, George Dance, John Hoppner, Thomas Lawrence,

Lawrence, and Thomas Stodhard, esqrs. in rotation, council.

John Flaxman, Henry Feech, Thomas Lawrence, Joseph Norskens, M. A. Shee, James Northcote, John Hoppner, Henry Thomson, and John Opie, esqrs. visitors.

Joseph Farington and George Dance, esqrs. auditors.

And a premium of a silver medal was voted to Mr. William Tallemach, for the best model of an academy figure.

Board of Agriculture.

Premiums offered by this Board.

[Continued from page 179.]

Operation of Tillage.—To the person who shall report to the Board the result of the most satisfactory experiments on the various operations of tillage—*the gold medal.* It is required that the soils on which the experiments are made be carefully described, and that the implements with which the operations are performed be explained. Accounts, verified by certificates, to be produced on or before the first Tuesday in March 1806.

Food for Mankind.—To the person who shall draw up, and produce to the Board, the most satisfactory accounts, founded on specified facts, of the comparative food for mankind, produced by the application of grass land to cows, for butter and cheese; to oxen for beef; or to sheep for mutton—*the gold medal.* Accounts to be produced on or before the first Tuesday in March 1806.

Food for Mankind.—To the person who shall draw up, and produce to the Board, the most satisfactory account, founded on specified facts, of the proportionate difference between grass and arable land, in producing food for mankind—*the gold medal.* Accounts to be produced on or before the first Tuesday in March 1806.

Paring and Burning.—To the person who shall report to the Board the result of the most satisfactory experiments made by, or under the inspection of, the reporter, in the paring- and burning-husbandry—*the gold medal.* Accounts, verified by certificates, to be produced on or before the first Tuesday in April 1806.

Paring and Burning.—To the person who shall report to the Board the result of the most satisfactory experiments made by, or under the inspection of, the reporter, to ascertain the proper depth of paring, in order to burn, relative to the quality of the soil—*the gold medal.* Accounts, verified by certificates, to be produced on or before the first Tuesday in December 1806.

Burning Clay, Loam, or Marl.—To the person who shall make, and report to the Board, the most satisfactory experiments

riments to ascertain the utility of burning clay, loam, or marl, for the purpose of manuring—*the gold medal.* It is required that equal portions of land (not less than five acres) be cultivated, the one thus manured, and the other without manure, for the comparison, during three years, each portion under similar crops. The quality of the soil, the expense of burning and carting, and the products of the respective portions, to be reported to the Board, and verified by certificates, on or before the first Tuesday in March 1809.

Leases.—To the person who shall draw up, and present to the Board, covenants consistent with the interests of landlords and tenants, that shall point out the best means of preventing the tenant from leaving his land in an exhausted state at the expiration of his lease—*twenty guineas.* To be produced on or before the first Tuesday in May 1805.

BATH AGRICULTURAL SOCIETY.

The annual meeting of this respectable society began on Monday the 10th of December, when the several committees met at Hetling-house, in Bath, belonging to this society, and the residence of its secretary, and made all the necessary arrangements for the sh w of cattle, implements, &c. Several excellent specimens of store cattle were shown and examined in a yard adjoining; after which the company dined together at the White Hart tavern. Sir G. O. Paul was in the chair; and there were present, lord Cawdor, sir John Smith, sir J. Hippesley, Messrs. Dickenson and Gore Langton, the members for Somersetshire; Mr. Hobhouse, M. P.; Mr. Eastcourt, M. P.; Dr. Parry; Mr. F. Sitwell, M. P.; Mr. Paul; Mr. Billingsley; Mr. Ashley, Mr. Acland; Mr. Dyke; Charles Gordon Grey, esq.; Mr. Biggs; Mr. Lethbridge; Thomas Crooke, esq. &c. &c.

Captain Norton, an American gentleman, who has visited this country for agricultural information, was elected an honorary member; as were Mr. Davy, professor of chemistry, and Dr. Currie.

The meeting at Hetling-house, on Tuesday, was most numerously attended.

Benjamin Hobhouse, M. P. esq. in the chair in the absence of the duke of Bedford, the president, who was prevented from attending.

Lord Somerville, also, was prevented from attending, by indisposition.

Several excellent fat cattle were shown alive in the yard; among which Mr. Eldridge showed an excellent two years

old new Leicester sheep; Mr. Grey, three good new Leicester, of one, two, and three years old; Mr. Jones, near Wellingford, two sheep of mixed breeds, Dorset and Leicester, and Leicester and Wilts.

Several excellent specimens of fine wool were produced and examined, particularly from sheep of crosses between the Spanish, Ryelands, and Wilts.

Specimens of cloth were also laid before the society from English wool, much exceeding in quality any before made from wool imported from Spain.

The first adjudication of the annual gold medal, left by the late lamented duke of Bedford, and called the "Bedford medal," was made to Mr. Arthur Young, for his Essay on the Nature and Properties of Manures, there being several other candidates. Sir J. Hippesley was elected a vice-president, and between fifty and sixty new members, resident in different parts of the united kingdom. Premiums to encourage friendly or benefit societies among the labouring poor were adjudged, and a new one established for the encouragement of female friendly societies. The company retired to the White Hart to dinner, where the utmost harmony prevailed till a late hour.

On Wednesday morning the carcases of the fat cattle, which had been viewed alive on the preceding day, and examined by Messrs. Grey, Paul, Ashley, and two other gentlemen, who were appointed judges, were examined; after which B. H. Hobhouse, esq., the chairman, adjudged the premium to Thomas Crooke, esq., for the best heifer and calf: they were of the Tytherton breed, or two parts French and one Devon. To Mr. Glyde, of Preston, near Yeovil, the prize for the best sow and her offspring: they were between the China and Leicester breed, and remarkable fine ones. To Mr. Troy, near Monmouth, for the best fat sheep of the new Leicester breed; and to Mr. Lewis the prize for the best fat spayed heifer, being of the Glamorgan breed. Several implements and other things were exhibited, which want of room obliges us to omit.

IMPERIAL ACADEMY OF SCIENCES AT PETERSBURGH.

The following has been proposed by this academy as the subject of a prize for the year 1806:

There are a few subjects in natural philosophy, which in regard to those parts susceptible of explanation, have been examined with more success than light; but the nature of this wonderful matter is still little known, and it is not improbable that we are entirely unacquainted with it. Two hypotheses,

hypotheses, equally celebrated by the names of their authors, have been formed on this subject: that of Newton, which makes light to consist in material emanations from luminous bodies; and that of Euler, according to whom it arises from the vibrations of a particular elastic fluid which are produced by the action of luminous bodies. The founder of the modern chemistry, the illustrious Lavoisier, has given a third hypothesis in regard to light; which is, that there exists in nature a peculiar matter which is the productive cause of the sensation denoted under the name of *light*; that the matter of light is subject to chemical affinities, in consequence of which it is susceptible of combining with other bodies, of fixing itself in them, of being disengaged from them, and of producing in them sensible modifications; that by the effect of its great affinity for oxygen it reduces it, with the concurrence of caloric, to that aëriform state under which it enters into the composition of atmospheric air; and that the fire manifested in the combustion of bodies results from the decomposition of the oxygen gas of the atmospheric air operated by the combustible according to the laws of affinity, in virtue of which the oxygen, which forms the base of this gas, being absorbed by the burning body, the caloric and matter of light become free and are disengaged. However uncertain and subject to difficulties may still appear the existence of a matter of light, and the reality of its affinities, on which the illustrious author of the hypothesis expresses himself with a reserve worthy of so great a searcher into nature, it is however beyond all doubt that this ingenious idea, which is not entirely destitute of support from experience, exhibits a kind of research highly interesting to the progress of natural philosophy. If there exists a matter of light, if it be subject to chemical affinities, and diffused around us, it may, by the combinations into which it enters with other bodies, have a striking influence on them and on several natural phænomena. The advancement of our knowledge in regard to this matter would consequently furnish us with results which, by giving us further information in regard to the secret springs of nature, might, perhaps, throw new light on a number of its operations. In consideration of these reasons the Imperial Academy has thought it would be advantageous to the progress of science to propose publicly a prize of 500 rubles, which will be adjudged to the philosopher who shall make, and communicate to it, "the most instructive series of new experiments on light considered as matter; on the properties which he may be authorized to ascribe to it; on

 the

the affinities it may appear to have with other bodies either organic or non-organic; and on the modifications and phænomena manifested in these substances in virtue of the combinations into which the matter of light has entered with them."

Without entering into a history of the objections formed against this hypothesis, or of the researches made to unveil, in different modifications of bodies and of natural phænomena, the traces of the action of the chemical affinities of light, the academy observes, that these researches might perhaps be extended, and not without utility, to the Galvanic fire, the dazzling splendour of which, in large Voltaic piles and on carbonaceous substances, imitates in some measure that of the solar light. In a word, the academy is satisfied with announcing generally the subject of the prize, in order that the learned who wish to employ themselves in it may not in any manner be fettered in the points of view under which they may be led to consider and treat a matter so difficult, which has scarcely yet been touched, and which, however, deserves so much to be examined for the benefit of science.

The academy requests the learned of all nations, without excluding its honorary members and correspondents, to labour on this subject. It thinks it its duty to exclude none but the members who are to discharge the function of judges.

The learned who intend to be candidates for the prize must not put their names to the essays, but only a motto or device, adding a sealed note having on the outside the same device, and in the inside the name, quality, and residence of the author. None of the notes but that belonging to the paper which gains the prize will be opened. The rest will be burned.

The essays, written in a legible hand, either in Russian, French, English, German, or Latin, must be addressed to the perpetual secretary of the academy, who will deliver to the person commissioned by the author a receipt marked with the device and motto accompanying the essay.

The essays will be received till the 1st of May 1806 exclusively; and the author of that which in the opinion of the academy is entitled to the prize will be announced in the public meeting held in the month of July the same year.

The successful essay is the property of the academy, and the author cannot cause it to be printed without special permission. The other essays may be demanded from the secretary, who will cause them to be delivered at Petersburgh to those deputed for that purpose by the authors.

LI. *In-*

LI. *Intelligence and Miscellaneous Articles.*

GEOGRAPHY.

A LETTER from St. Petersburgh, dated November the 2d, says, "The large hydrographical chart of the White Sea, which has been some time preparing, under the direction of lieutenant-general Golenischtscheff-Kutusoff, will soon be printed. A trigonometrical survey of this sea, comprehending the bays and a part of the northern ocean, was made between the years 1798 and 1801; at the same time the depth and nature of the bottom were ascertained and examined, and sixteen principal points of the coast were determined by astronomical observation; so that this chart, by the indefatigable zeal of general von Kutusoff, has been brought to a considerable degree of perfection, and will render the navigation of that sea much safer than it hitherto has been.

ASTRONOMY.

We have received a note from Mr. Joseph Emmanuel Pellizer, a gentleman who some time ago published a new system of astronomy, containing some doctrines very different from those generally received. We cannot enter into the arguments he offers in defence of his system; but as he mentions one decisive test by which the question may be settled, we shall state it as shortly as we can for the consideration of astronomers.

According to the Nautical Almanac for 1805, there will be a conjunction of the moon and sun on the 30th of March next, at 10^h 53′ P. M.—According to Mr. Pellizer's calculation, that conjunction will take place March 29th, 20′ 2″ A. M.

Mr. Pellizer proposes that the distance of these two luminaries should be observed three days before the conjunction—say on the 26th of March, at 20′ 2″ A. M.; when it will be found, according to him, 39° 30′ and a fraction—while, according to the received astronomy, it ought to be 58° 40′.

POISON OF THE VIPER.

To determine, in a certain manner, whether the poison of the vipers in the forest of Fontainbleau * is as subtile as imagined, Dr. Paulet has been induced to make some experiments on this subject, and the result has been agreeable to expectation.

* See page 91 of this volume.

expectation. Till the month of October last, all the facts known respecting the bite of these animals attested that their poison was mortal, either to man or to the small animals subjected to experiment. It was therefore necessary to ascertain whether it would be equally prejudicial to stronger animals, such as the horse: one procured for this purpose laboured indeed under a disease of the breast, but he was still strong, ate and drank, and, according to every appearance, likely to live two months longer. He fed on grass while preparations were made for the experiment, and gave no signs of his respiration being confined. He was bit in the cheek in two different places, and immediately after the part swelled in a sensible manner. As no remedy was applied, the tumour increased, and advanced to the neck, the head became deformed by the size of the tumour, which was more sensible on one side; respiration became quick and very laborious; the extremities cold; and he died at the end of fourteen hours. The opening of the body, which was performed by veterinary artists, showed that the tumor was visibly gangrenous.

At the end of October, another horse, but stronger and more vigorous than the preceding, though he had been subject for several years to a lientery, but in a state of convalescence, was subjected to a new experiment; he was bit in the lower lip by the same viper which had occasioned the death of the former. The same symptons took place; that is to say, the part was sensibly tumified; but a remedy being applied in time, under the direction of Dr. Paulet, he had the satisfaction next day, at noon, of observing that the dangerous symptoms had disappeared, and that the horse was in a good state, though weak from fatigue and the loss of blood he had sustained the preceding evening. Three days after, being fit for labour, he performed a journey of three leagues with a carriage, and mounted by a postillion, and, at the same time, was cured of his lientery.

A third experiment was made, a few days after, on another horse belonging to a veterinary artist, who took charge of his treatment; he gave him proper drink; but, on the third day, he was not entirely cured of his tumor, which was still livid in the centre.

"It may be concluded," says Dr. Paulet, "from these experiments, that the bite of this reptile may be fatal to a horse which receives no assistance; but that if a remedy be applied, he may be speedily and easily cured; and that the same treatment is applicable to man, and affords hopes of a similar result."

2 Such

Such has hitherto been the researches made in regard to this reptile, which has all the characters of a viper; that is to say, the teeth or hooks bent forwards, moveable, retractile, hollow, and furrowed; with a glandulous apparatus for filtring the venom, a reservoir to contain it, an aperture at the bottom of the tooth to permit its entrance into the interior, and a furrow on the outside to facilitate its flowing into the wound which it occasions; the tooth being cut into a gutter is open at the extremity, and pointed like a needle.

Since the first discovery of these animals, fifteen individuals of the same species have been killed or taken alive; among that number there were two females, one of which contained sixteen eggs, and the other six, which forms a total of thirty-seven individuals destroyed. More than three hundred persons are employed in the pursuit of these animals, and it is hoped that it may be possible to destroy them in the forest of Fontainbleau.

Dr. Paulet is almost certain of curing the effects produced by the bite of this reptile, not by volatile alkali, nor the cautery, but by more simple means, which he proposes to make known.

METEOROLOGY.

Kingston, Jamaica, Sept. 22.—On the 30th ult. at fifteen minutes past eleven P. M. a single but violent shock of an earthquake was felt at St. Ann's Bay; its direction appeared to be from north to south; its duration about four seconds; moon waning; thermometer 85; no wind, but was preceded by a solemn stillness of the atmosphere. The brute creation, immediately previous and subsequent to the concussion, were extremely agitated, as was manifested by their cries of alarm. For several hours before the shock, the air was close and almost irrespirable; a heavy fall of rain took place the following day. The usual rumbling noise and undulatory motion of the earth, which generally attends those phænomena, were not perceived.

St. Jago de la Vega, Oct. 6.—A correspondent who resides near the Black River has transmitted to us the following account of a most awful and alarming phænomenon, which made its appearance in Middle Quarters, in the parish of St. Elizabeth, on Monday the 24th of September ult. about four o'clock in the afternoon. It began with very heavy black clouds, as if there were a deluge of rain ready to fall. It was presently afterwards accompanied with a dreadful roaring noise, as if a violent squall of rain with wind was coming on, but much more loud and horrible. There

There was soon the appearance of a large globe rising and ascending into the atmosphere, occasioning very violent commotions and convulsions in the earth. The fall of trees was distinctly heard, and large branches thereof, together with innumerable birds, were seen carried to an immense height in the air, the clouds, at the same time, convulsed in the most awful manner: There was seen what resembled a water-spout, but no water fell from it. This continued its course from the north-east to the southward, carrying all before it, tearing up logwood, cotton trees, &c., by the roots, and whirling up in the air the limbs of numbers of the largest trees, having, at the same time, the appearance of fire, attended with a thick black smoke, which ascended from it in its course, and a report like guns went off. This continued nearly an hour, and its course was upwards of a mile. Fortunately it kept where no dwellings or buildings stood, otherwise they must have been destroyed, as the strongest buildings could not have withstood the violent force of this awful convulsion of nature.

ANTIQUITIES.

Some Russian peasants, in digging for the foundations of a fortress on the fords of the Limar, at the mouth of the Danube, discovered lately a tomb which the antiquaries of that country consider as that of Ovid; the reasons given for this opinion are—first, that it stands on the site of Tomi, to which that unfortunate poet was banished; second, that this spot has long been known in the country under the name of *Laculi Ovidioli* (the Lakes of Ovid); third, that there was found in the tomb a bust, which, being compared at Petersburgh with the heads of the beautiful Julia, the daughter of Augustus, has been found to have a perfect resemblance. The Russians have given to their new fortress the name of *Ovideopolis*.

Notwithstanding these details, given in the Russian journals, we do not believe that this tomb is that of Ovid. We are acquainted with no medals of Julia but such as were struck in countries at a distance from Rome, and by which it is difficult to determine precisely the character of her form; besides, it is not probable that Ovid should cause himself to be interred with the portrait of the daughter of Augustus.

Some time ago two Wallachians, named Jeremiah Thoma and Zacharias André, found in the forests of the Bannat, near Kis-oclos, belonging to count Hunyades, the former 214, and the latter 66 Greek medals in gold, which they carried

carried to the mint at Carlsbourg, whence they were sent to the royal treasury at Hermanstadt, the capital of Transylvania, and to Vienna. To judge from the impression, these medals were struck in the time of Lysimachus. Their intrinsic value is about 2800 florins (300l. sterling). A considerable number of similar medals have been found at different times in Transylvania; so that this new discovery cannot be considered as a direct increase of our neumismatic knowledge, if we except two medals of king Pharmaces and his general, Asander.

The treasury of Hermanstadt has received intelligence, also, that evident traces and the ruins of a town, very considerable by its extent, have been discovered in the mountain of Gredistye, in the same county*. In the same neighbourhood, and particularly the mountain Gattano, some Wallachian priests have found several antique medals of gold, about four hundred of which have already been sent to the treasury at Hermanstadt; each of them is equal in weight to about two ducats and a quarter;—the price for which they have been purchased by the treasury from those who found them, is 4,217 florins (about 450l.). All these medals are in fine preparation; on one side they exhibit the figures of three men, the first and third of whom bear axes; at the bottom is the word ΚΟΣΩΝ; on the reverse is seen an eagle, holding in its right claw a crown. In the catalogue of the cabinet of Vienna†, Eckhel ascribes this emblem to the town of Cosæ, in Etruria, as Tristan Patin Havercamp and other antiquaries had done before; on the other hand, in his *Doctrina Numorum*‡: he shows that these medals ought to be ascribed to Marcus Junius Brutus.

A letter from Rome says: "This city is engaged with the greatest activity in repairing its losses. The pope neglects nothing that can improve or encourage the arts. People are employed in digging around the triumphal arch of Severus, which is almost half buried. Fifty galley slaves, brought from Civita-Vecchia, are engaged in this undertaking. The same labour has been several times undertaken in the course of the last three centuries, but the places where these researches were made had always been again

* No inscriptions capable of giving further information have yet been found; a brick with the letters PERS co Rilo only has been dug up.

† Vol. i. p. 14.

‡ Vol. i. p. 90, and vol. vi. p. 23, et seq.

filled

filled up; which will never again be the case, because the works are surrounded by a parapet, as has been done in regard to Trajan's pillar. Researches of the same kind will be made around other ruins, and in particular near the columns of the temple of Jupiter Stator, which are two-thirds buried. Workmen are now employed in clearing the pyramid of Cestius from the bushes with which it has been covered for several years, and the roots of which had begun to displace the stones.

The researches at Ostia are still continued. At present they are carried on in the site occupied by the antient city. The foundations of several houses have been discovered; and also of some temples, plans of which are now making by the architect Balistra, who attended lord Elgin to Greece. It is hoped that this discovery will give some information in regard to the method of building, and the domestic œconomy of the antients.

Apartments are preparing at the Vatican to receive such curious articles as may be found at Ostia. Other arrangements are also making, and artists are employed in erecting the statues of the Belvidere. It is hoped that the pope will purchase the *Faune endormi* which formed part of the Barberine collection, and which now belongs to the sculptor Paccetti.

The science of antiquities is also cultivated at Rome with great zeal. A new edition of the *Roma Antica* of Venuti has been published, with supplements and notes by Philip Visconti, brother to the celebrated antiquary of that name settled in France. The learned Zaega is still employed on his catalogue of all the Coptic manuscripts in the library of cardinal Borgia. He has been engaged also several years on researches in regard to the topography of antient Rome; and it is supposed that he will throw great light on this subject.

In the month of February last several antient monuments were discovered at Bois-de-Vaux, near Vidy, at a small distance from Lausanne. This discovery was made by accident in working at the mines. This place, according to some authors, was the site of the supposed city of Carpentras; and according to others, perhaps on better authority, of the antient Lausanne. A beautiful bas-relief, in bronze, representing a taurobolus, presented by the council of Lausanne to the museum of Berne, where it is still preserved, was discovered here in 1629. About the end

end of the last century some tombs of white marble were dug up, and one of them is still employed as the bason to a fountain. The researches already made have left uncovered, at the depth of two feet below the surface, on the edge of the spot on which the city seems to have been placed, two parallel walls of mason-work at the distance of five or six feet from each other. At the depth of five feet there was found a cellar filled with a number of urns of earthen ware, placed close to each other, some of which were broken by the workmen. There were found also bronze medals, and silver of the lower empire, having on them the impression of Philip. Besides several beautiful medals of Augustus, Domitian, Trajan, Adrian, Antoninus Pius, Marcus Aurelius Faustina, Septimus Severus, Constantius, Chlorus, and Valentinian, there were found a steel stylus, a metal mirror, and some vessels of black and red earth covered with figures in bas-relief; the torso of a woman, the small statue of a horse, and an inscription in which has been decyphered the name of Julius Cæsar; a beautiful silver medal with two heads, representing on one side the emperor Claudius, and on the reverse that of the young Cæsar, Nero, &c.

BOTANY.

It has hitherto been supposed that the plant called by Linnæus the *Lichen islandicus* does not grow any where but in the regions of the north. Don Mariana Lagaa, however, who belongs to the royal botanical garden at Madrid, in a tour through Spain to complete the *Flora Hispanica*, discovered it in the park of Pajares, in Asturia, and in many other places, where it grows in great abundance. This plant is employed by the physicians as a remedy for the phthisis.

COATING COPPER WITH PLATINA.

M. Strauss announces in Gehlen's journal, that a solution of platina precipitated by ammonia, washed, dried, and exposed to a red heat for half an hour in a covered crucible, may be amalgamated with from five to seven parts of mercury by trituration in a warm mortar. This amalgam may be laid over copper, and the mercury be driven off by heat: a second coating is applied mixed with chalk and sprinkled with water, and the plate is again ignited. The plate is afterwards burnished. By this application copper vessels may be defended from the action of acids.

TANNING.

M. Hermbstädt, of Berlin, has announced that the *Tormentilla erecta* (tormentil or septfoil), a plant which grows almost every where; and the *Polygonum bistorta* (great bistort or snakeweed), contain such a large quantity of tannin as to make them preferable to oak bark for tanning. One pound and a half of tormentil, or three pounds of bistort, will tan a pound of dry hide which requires seven pounds of oak bark. He likewise recommends the use of the leaves of the oak tree in tanning leather.

ICHTHYOLOGY.

A very uncommon fish was on Saturday the 22d of August exhibited in Portsmouth market: its shape bore resemblance to the smaller class of quadruped animals. It had no appearance of fins; its eyes were scarcely visible; it had two horns, which it put out at pleasure. Its appearance in the water was very unpleasing but for the relief of some beautiful variegation of colouring on its skin, shading to purple and red. It was about ten inches long, but was not of the species of sea cow.

LECTURES.

On Monday the 25th of January, Mr. Macartney will commence his lectures at St. Bartholomew's hospital upon comparative anatomy and the laws of organic existence. In these lectures the structure and functions of organized beings are fully described, with a comparative analysis of the mental operations of man and animals, and the general history of diseased actions.

Mr. Blair's physiological lectures, for the information of scientific and professional gentlemen, amateurs of natural history, students in the liberal and fine arts, &c. will recommence on Tuesday the 8th of January, to be continued every succeeding Tuesday and Friday, at eight o'clock in the evening. Further particulars may be learned at Mr. Blair's house, Great Russell-street, Bloomsbury-square; where may be had a printed syllabus of the lectures.

At the theatre of anatomy, Blenheim-street Great Marlborough-street, Mr. Brookes will commence his spring

course of lectures on Anatomy, Physiology, and Surgery, on Saturday 19th January, 1805, at two o'clock. In these lectures, the structure of the human body will be demonstrated on recent subjects, and further illustrated by preparations; and the functions of the different organs will be explained.

The surgical operations are performed, and every part of surgery so elucidated, as may best tend to complete the operating surgeon.

The art of injecting, and of making anatomical preparations, will be taught practically.

Gentlemen zealous in the pursuit of zoology, will meet with uncommon opportunities of prosecuting their researches in comparative anatomy.

Surgeons in the army and navy may be assisted in renewing their anatomical knowledge; and every possible attention will be paid to their accommodation as well as instruction.

Anatomical *conversaziones* will be held every Sunday morning, at eight o'clock, in the museum, in which the different subjects treated of the preceding week will be discussed familiarly.

To these none but pupils can be admitted.

Spacious apartments, thoroughly ventilated, and replete with every convenience, will be open daily, until two o'clock, for the purposes of dissecting and injecting; where Mr. Brookes constantly attends to direct the students, and demonstrate the various parts as they appear on dissection.

An extensive museum, comprising a collection of preparations illustrative of every part of the human body and its diseases, the result of many years' labour, and great expense, is attached to this theatre, to which the students will have occasional admittance.

The inconveniences usually attending anatomical investigations are counteracted by an antiseptic process, the result of experiments made by Mr. Brookes on human subjects, at Paris, in the year 1782; the account of which was delivered to the Royal Society, and read on the 17th of June, 1784. This method has since been so far improved that the florid colour of the muscles is preserved, and even heightened.

Pupils may be accommodated in the house.

METEOROLOGICAL TABLE
By Mr. Carey, of the Strand,
For December 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Nov. 27	35°	38°	35°	·02	20°	Cloudy
28	35	35	32	29·96	12	Cloudy
29	35	37	33	·91	10	Cloudy
30	34	37	33	·91	10	Fair
Dec. 1	33	41	35	30·02	11	Cloudy
2	35	37	31	·27	2	Cloudy
3	34	36	28	·20	15	Fair
4	27	37	40	29·79	10	Cloudy
5	42	47	44	·09	2	Small rain
6	35	38	40	·09	0	Foggy
7	41	43	42	·58	2	Cloudy
8	43	44	41	·87	1	Cloudy
9	42	44	40	·83	0	Rain
10	39	46	44	·86	5	Cloudy
11	45	47	45	·70	4	Fair, stormy at night
12	40	46	46	·49	5	Fair, stormy at night
13	47	47	45	·10	16	Fair
14	44	47	44	·48	17	Fair
15	44	46	37	·88	18	Fair
16	34	39	35	30·09	15	Cloudy
17	31	36	32	·16	10	Fair
18	31	34	30	·26	5	Fair
19	28	29	28	·36	0	Snow
20	28	29	28	·15	10	Fair
21	28	34	34	29·99	5	Fair
22	34	34	30	·61	12	Cloudy
23	31	34	24	29·59	6	Cloudy
24	19	29	30	·70	5	Fair
25	34	38	34	·54	0	Cloudy
26	34	34	33	·46	0	Rain

LII. *Description of an Instrument for equalizing the Pressure and Efflux of non-elastic Fluids.* By Mr. JOSEPH STEEVENS.

To Mr. Tilloch.

SIR,

HEREWITH you have a drawing and description of an instrument for equalizing the pressure and efflux of non-elastic fluids. The principles on which it depends are the same as that which I constructed for the Mathematical Society about four years since, but which had no provision for refilling during an experiment, Should it merit a place in your valuable publication, it is very much at your service. At some future time I purpose to submit to your consideration a gasometer much simplified by various alterations, and rendered more universal by the addition of this instrument. I am, sir,

Your obedient servant,
JOSEPH STEEVENS.

26, Garlick Hill,
Dec. 7, 1804.

Having frequently had occasion to regulate the pressure and efflux of water with some degree of accuracy, and finding it usually attended with much difficulty, I was induced to try what could be done by the re-action of the atmosphere. The instrument represented in the annexed drawing (see Plate VIII.) is the result of several trials, and appears to be at once simple and accurate, and is at the same time, I conceive, applicable to every purpose for which such an instrument can be required.

There are several other constructions far more elegant and equally useful with that of which I have made choice. I have preferred distinctness of parts to symmetry, my principal object being the explanation of the principle rather than the construction of the machine. AB is a glass or metal cylinder about 24 inches long and 4 inches diameter, cemented at the bottom into a brass socket on the foot C, and at the top into the cap A, through a collar of leathers in which is inserted a copper tube, *ef*, about 3-10ths of an inch in diameter in the bore. *g* is a cock screwed into the socket B, the orifice of which is about 1-4th of that of the tube *ef*.

Having the machine thus constructed, unscrew the nut *d*, and fill the vessel nearly full of water: screw it again into its place, and thrust the tube *ef* down until its lower end is a little below the cock *g*; which may now be opened, and a small

a small portion of the water will issue, but will cease to run as soon as the air in the upper part of the vessel is so rarefied that its spring, together with the weight of the column of water above *r* or *g*, are exactly equivalent to the re-action of the atmosphere. Raise the tube *ef*, and the water will issue with a continued and uniform stream, discharging equal quantities in equal times, without regard to the height of the column q r, provided it be within the limits of atmospherical pressure.

The reason is obvious; for it is evident that the pressure of the water at *r* would be proportionate to the whole height of the column *rq*, were the atmosphere to act equally at *g* and *q*; but since the air is made to enter through the tube *ef*, and thereby to counteract the column *fq*, it follows that the pressure at q will be less than that at g by the weight of the column q f. Now the pressure at *q* is in the inverse ratio of *fq*, therefore the pressure at r will be uniformly the same. For while the vessel is closed at the top, and the air made to enter through the tube *ef*, the pressure on any plane, *nn*, will be equal to the column *qf*, together with the pressure on the surface *q*; for as the weight *qf* decreases by the reduction of the water, so does the pressure of the air on the surface increase by its easier access (in having to counteract a less column of water), the increment of the one being always equal to the decrement of the other.

I shall now proceed to explain that part of the instrument which is employed for keeping up a constant supply of water when attached to a gasometer or the like, where an experiment is required to be continued a considerable length of time without intermission. V is a vessel provided with a cock h and funnel k, having also a cock l communicating with the top of the machine near d; and a tube m n, and cock p, communicating with the bottom of the machine AB. Shut the cocks l and p, and open k; fill the vessel V and tube *mn* with water until it rises above k, which must now be shut, and the cocks l and p opened; by this means the whole is formed into one vessel, and the operation is no more than transferring the fluid from one part of the machine to another, the pressure and efflux remaining the same. It will easily be perceived that the pressure may be increased or decreased at pleasure by slipping the tube ef upwards or downwards as circumstances may require. The instrument in the Mathematical Society's repository is used (besides the above purposes) for the illustration of all those experiments termed hydrostatic paradoxes.

LIII. *On the Principles of Pump-Work, illustrated and applied in the Construction of a new Pump, without Friction, or Loss of Time, or Water, in working; humbly proposed for the Service of the British Marine, with the Privilege of His Majesty's Royal Letters Patent.* By BENJAMIN MARTIN.

[Continued from p. 229.]

1. THE particles of fluids and solids are equally hard, solid, and impenetrable.

2. Fluid particles are affected by gravity, act upon each other, and are subject to all the affections and laws of motion in common with all heavy bodies.

3. Their fluidity is owing principally, if not solely, to their not being in contact with each other.

4. For that reason the particles of fluids, as such, can produce no friction, or impediment to motion, among themselves.

Fig. 1.*

5. The weight of a perpendicular line of fluid particles, as *cd*, is in proportion to the number of such particles, that is, to the height *cd*.

6. Therefore the pressure of the line *cd* on a fixed point *d*, in the bottom of the vessel ABCD, is proportioned to its altitude *cd*.

7. The pressure of the whole fluid upon the bottom of the vessel, is therefore in proportion to the height of the fluid and the area of the bottom of the vessel.

8. From the nature of fluidity, a constant endeavour towards an equilibrium, or state of rest, must obtain among all the particles.

9. But in case of an equilibrium of particles in a fluid, each particle must have a central force every way equal.

10. Therefore fluids press every way equally.

11. Consequently, the lateral pressure of a fluid is equal to its perpendicular pressure at the same depth.

12. The lateral pressure against the line BD is just half that upon the line CD in the bottom, if BD be equal to CD.

13. The re-action of the particle *d*, as being fixed, is equal to the pressure of the line *cd*, and must entirely sustain it.

14. But if a hole EF be made in the bottom of the vessel,

* See Plate V, given in our Number for November.

sel, there will be nothing to sustain the column *a*FE*b* of the fluid over it, which therefore must descend through it by its weight.

15. The particles on the surface contiguous to the descending column at *a* and *b* will lose their lateral support, and must therefore fall in and descend; and as this will be the case of all the particles in the surface, the whole surface will also descend.

16. By this means there will be supplied a constant descending column of the fluid through the hole till all is run out.

17. If the hole were made in the side of the vessel at D, the fluid would issue out by the same lateral force, and with the same velocity.

18. If the descending column be received into a recurved hollow tube or pipe FNGHI, of any form or size, it will rise in that pipe to the same horizontal level with that in the reservoir AD, viz. to the line AH, and no higher.

19. The air being taken out of the tube NHI, will cause the water to descend in the reservoir from AB to KL, by the pressure of the air AXYB over it, and at the same time it will rise from H to I in the tube.

20. Since the water in ABKL is equal to that in the tube from H to I, the velocity of that in the reservoir is to the velocity of that in the tube as AK to HI, or as the square of the diameter of the tube to the square of the diameter of the reservoir.

Fig. 2.

21. If AB be a surface of water, in which a tall tube or pipe BE is placed, and open at the end B; then if the air be extracted from this tube at the upper end E, the water will rise therein to the height BD by the pressure of the column of air AX, upon an equal base.

22. The weight of the column of water BD will be precisely equal to the weight of the column of air on the same base A or B, and extending to the height of the atmosphere.

Fig. 3.

23. It is found by experience, that when the air is of a mean gravity it will sustain a column of mercury in the tube AB of a barometer to the height C, equal to $29\frac{1}{2}$ inches.

24. It is also known that mercury is about 14 times heavier than water; therefore the pressure of the air in such

a case

a case will raise water to the height of $29\frac{1}{2} \times 14 = 413$ inches, or 34 feet 5 inches, as at F (fig. 2).

25. When the air is heaviest the mercury rises to 31 inches nearly, corresponding to which is 36 feet of water in the pipe at D (fig. 2).

26. And in the lightest state of the air the mercury rises but a little above 28 inches, to which, in the pipe of water, answers about $32\frac{1}{2}$ at G.

27. Hence the greatest height to which water can be raised by a pump will be less than 36 feet, and it may always be raised to the height of 30 feet at least.

Fig. 4.

28. Suppose A be a reservoir of water, with a pipe AC; then upon AC, as a diameter, describe the semi-circle ABC, and from any point D therein let fall the perpendicular DE; and join AD and DC.

29. If now a hole be made at E, the water will issue out with a force proportional to the height AE of the fluid above.

30. The velocity of the effluent water will be as the square root of the height AE, and with an uniform velocity.

31. The time of its descent from E to the horizon at H, will be as the square root of the perpendicular descent EC, or height of the fall.

32. The horizontal distance CO, to which the water will spout from a hole N in the centre, is equal to AC, the altitude of the water.

33. If we take NF = NE, then water spouting from holes at E and F will go to the same horizontal distance CH, which will in all cases be less than CO.

34. The form of the curve EKMH, which the spouting fluid describes, is that called a *parabola*.

35. The weight of a cubic foot of water is $62\frac{1}{2}$ lb. averdupoise weight; hence the weight of a cylindrical foot is $49\frac{1}{10}$ lb.

Fig. 5.

36. If a pipe or tube ABDC be placed in water at A, and a plane at AC which exactly fits it, and moves freely in it, be suspended by a rod or wire fixed at D to the end of a lever DE, whose fulcrum or centre of motion is F. Then supposing the tube filled to the top with water, let it be equipoised by a weight HGI hanging from the other end of the balance at E. Therefore if the tube AB be 12 feet high, 12 inches in diameter, and of a cylindric form or

 bore,

bore, the weight of the water which fills it is 589·2 lb., and equal to the weight HGI.

37. The weight on the plane AC will always be the same while the fluid stands at the same height AB, whatever be the form or capacity of the pipe ABDC above it.

38. If the top BD be covered close, and in the cover be made a small hole; then if a weight HIKL be appended to the former, it will cause the water of the tube to rise through that hole in form of a *jet d'eau*, and with a velocity that will carry it to a certain perpendicular height DO.

39. This height will be such, that a body BVOD of the fluid, of the same diameter with the pipe AB, will be equal in weight to the superadded weight HL.

40. The velocity with which it rises from the hole at D, is the same as a heavy body acquires in descending through the same height VB.

41. The space through which any body descends in a second of time is $16\frac{1}{10}$ feet; in two seconds it descends through four times that space; in three seconds, through nine times that space; and so on: the descent is therefore known for any given time.

42. If a third weight KLMN be added to the two former it will cause the jet to rise higher still, viz. from B to W.

43. If upon the axis of the pipe continued out, be described the parabola DPRS, and through V and W be drawn the right lines VP, WR, to the parabola (in the points P and R), and parallel to the horizon. Then these lines VP, WR, will be as the square roots of BV and BW (the heights of the jets), and therefore as the velocities of the water at D, which produce those jets, respectively.

44. These lines VP, WR, will therefore, when compared with AV and AW, express the velocities of the jets compared with the weight KGL and MGN which produce them.

45. But the ratio of VP to AV is expressed by the angle VCP made by drawing the line CP. Now this angle will be greatest of all when the right line CP touches the curve, but does not cut it; which suppose to be at the point R.

46. Then in that case we have BW equal to BA, and consequently the weight HN equal to the weight HGI.

47. Therefore the velocity of a fluid at D will be greatest in proportion to the force which produces it when that force is double of the force that will just sustain a column of water to the given height AB. And this is the first maximum in pump-work.

48. Hence if 589·2 lb. sustains a column of water in the

 pipe

pipe AB = 12 feet high, in equilibrio; twice that weight will produce a jet 12 feet above it, or a velocity of water at D greater in proportion to the height than any other weight can do.

49. But this velocity and altitude of 12 feet is not the greatest effect that this maximum force of 1178·4 lb. will produce; but some other altitude AG, and some other velocity acquired by a descent through WG, will be the maximum effect produced by the said given weight. See

Fig. 6.

50. For, since the weight 1178·4 lb. will sustain in equilibrio a column of water in the pipe to the height AW = 24 feet, it will produce a jet of water at any less height AG; and its effect will be proportional to that altitude AG, and the velocity of the jet at G conjointly.

51. Therefore let WPS be a parabola, passing through the point P such, that GP may every where be as the velocity acquired at G in descending through WG. Then it is plain, if we complete the parallelogram AGPO, the effect of this force will be every where as the area of that figure inscribed in the parabola, viz. AG × PG.

52. But the area of that figure is greatest of all when GW is one-third part of the altitude AW; and consequently when AG is equal to 16 feet, then the effect of the weight NHI = 1178·4 lb. will be a maximum, or greatest possible. And this is the second maximum of pump-work.

53. If the orifice of the pipe at G were quite open, the whole body of the fluid would rise to W in the same time with the jet, and the velocity of the plane or pallet AC would be the same in both cases by the action of the weight NHI.

54. Therefore, if the said weight was connected with a chain AG with many pallets AC fixed upon it, and passing over the wheel GED, moving on its centre F, it would, by a continual descent, cause a constant column of water to rise from G to W of 8 feet in length.

55. The velocity of the rising water, and consequently of the pallets AC, will be at the rate of 23·6 feet per second; and every such foot will contain 4·8 gallons; therefore the whole quantity of water raised by this maximum force will be 108 gallons per second, at the height of 16 feet.

56. Hence the nature of a chain-pump appears; and its utmost force (with a tube or pipe of any given bore) may be estimated; for that pump is only a constant succession

of pallets AC, passing over two wheels at the top and bottom of the pipe AG, and put in motion by the force of men instead of the weight HNI *.

57. If instead of the wheel GED a lever GM be used, then a weight R at the end M of the lever would have the same force and produce the same effect with the weight NHI, if it be in proportion thereto, as the distance FG to the distance FM.

58. Let now the plane AC represent the sucker, bucket, or piston of a common sucking-pump, placed at the bottom of the pipe, and the rod AG connected with the lever or handle GM. And let FG : FM : : 1 : 6. Then, since the column of water ABCD (fig. 5.) 12 feet high, weighs 589·2 lb., it will be sustained in equilibrio by somewhat less than 100 lb. = R, at the end of the lever GM.

59. If we suppose the muscular force of a man's arm equal to 100 lb. it would, acting at M, sustain the same column of water; therefore two such men would sustain a column of water 24 feet high = AW: which we may therefore call a maximum force.

60. If now it be required to raise water in a sucking-pump, it is evident that given maximum force will produce the greatest effect when the altitude of the water to be raised is AG = 16 feet.

61. In this case also the lever acts to the greatest advantage; for now the force which acts at M being 200 lb., is one-half more than the force 134 lb., which is nearly equivalent at M to the weight of the column of water AC 16 feet high. And this is a third maximum in pump-work, and follows immediately from the second.

62. In all mechanism, what is gained in power is lost in time; for now the motion of the point G, and consequently of the piston AC, is six times slower than the point M, the motion of which is determined by considering the lever GM as a pendulum vibrating about the point F, and being charged with two weights, one at G, the other at M, which are to each other as 785·6 to 200, or as 6 to $1\frac{1}{2}$; the distance of the centre of oscillation will thereby be found, and from thence the time of an oscillation, or motion through the arch *d*M*c*, will be known, and is 40‴; then if the said arch *c*M*d* be six feet, the arch *a*G*b* will be one foot.

63. Therefore the velocity of the piston AC is 12 inches

* This is upon supposition that in the chain-pump there is no friction, and that the pallets lose no water; but as one or the other of these cases must take place in that machine, it deserves no further consideration.

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in 40″ or 18 inches per second, if a lever be worked with its natural motion. But in the descent of the piston no water is raised; therefore only 18 inches of water is raised by one piston in two seconds, or the water raised in a single pump is not more than nine inches per second, which is about 3·6 gallons, or 216 per minute, which is short of a ton by 36 gallons.

64. But if the pump be so constructed with two pistons, that while one descends, the other ascends, the water will, in that case, always keep rising in the pipe; and the water delivered by such a pump would be 18 inches per second, or 432 gallons, or $1\frac{3}{4}$ ton per minute.

65. Such would be the state of pump-work in its utmost perfection if men could act like a weight, viz. always with the same tenor of force; but though the force of two men may be equivalent to 200 lb. for a few efforts at first working, yet this human force will soon abate and decrease, and it is found by experience, that for working a pump without ceasing but 10 or 15 minutes, one man can raise no more than about 30 lb. of water to his share; therefore six men, at least, must be employed for raising the above-mentioned quantity of 432 gallons of water per minute.

66. But such perfection is not to be expected in common pumps, for two reasons: first, they are subject to great friction between the piston and pipe, and other parts of the mechanism; and this is scarce ever so little as a third part of the charge of the whole machine, and therefore will require nine or ten men to raise that quantity of water instead of six.

67. But, secondly, the great imperfection of all common pumps working with a single piston is, that the water rises *per vicem*, or by fits; for while the piston is descending, the watery column A G is quiescent, and only moves when the piston rises; therefore every time the stroke is repeated, a new or additional force is required to give motion to the water, over and above what is necessary to continue that motion when produced.

68. Again, thirdly, the motion of the water by a single piston can never be equable. For suppose the jet B W (fig. 5.) was produced by the pressure of the atmosphere or weight of the water B D (in fig. 2.), then the velocity of the jet at the first instant will be as $\sqrt{BD} - \sqrt{BR}$, and the jet will thereby rise to V.

69. But the velocity of the jet must increase by the continued pressure of the column K D, and at last will be as $\sqrt{KD}$, and thereby produce the uniform jet B W. And

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something analogous to this will always be the case of a single pump, where the stroke of the piston is large, and its velocity nearly equal to that of the rising water.

70. But it is quite otherwise with the pump which has two pistons upon one pipe, and where the rising water is constantly in a uniform motion; for there the whole force is employed to continue that motion only, and the velocity of the water will always be as the square root of the difference between 36 and the height of the pump, or in the present case of fig. 6, as $\sqrt{20}$.

71. The piston playing at the bottom of the pipe or the top, makes no difference in the power to work the pump; since in both cases the same column of water AG is moved by the piston, the pressure of air on the column at G and A being equal.

72. The force of any column of a fluid to resist motion, is compounded of its quantity of matter and velocity; therefore while the force remains the same, the quantity of the fluid may be varied as you please, since the velocity will ever compensate any deficiency or redundancy of force that may happen on that account.

Fig. 7.

73. Thus suppose EKLI be the cistern of the head of a pump, in which the piston MN works, then the pipe ABCD may be in bore in any proportion less, and still the water shall be supplied to the cistern when the piston rises, with the same force and in the same time as it would be if the bore of the pipe were all the way the same with that of the head, or equal to KFHL.

74. In this latter case the velocity of the water will be the same with that of the piston, but in the former the velocity of the water will be to that of the piston as the square of MN to the square of BC, because the quantity of fluid in EFHI is to that in the contracted pipe ABCD in the same proportion.

75. If the pump be required to raise water 26 feet (as in fig. 7.), then since the height AG $=$ 26 is $\frac{2}{3}$ of 39 $=$ AX, the jet GX will be 13 feet; and since the air at a mean gravity is equal to a column of water 34 feet high, we have $34 - 26 = 8$; therefore the maximum force will produce a uniform velocity of near 29 feet per second; and the pressure of the air only a velocity of 22·6 feet per second, if the piston moves in a pipe ABCD of an equal bore throughout.

76. In this case the water would be wire-drawn, since the

the piston moves faster than the water can rise to follow it. Hence we see the great use of contracting the pipe AD and making the piston play in a large head EKLI, as by this means we lessen the velocity of the piston and increase that of the rising water, which can never be in any danger of being wire-drawn.

77. Since in the case of a piston's working in a pipe ABCD, the difference between 34 feet and the length of the pipe is always equal to half the length of the pipe, for the force to be applied to the greatest advantage; therefore 22·6 feet is the greatest height of such a pump, because in this case the velocity of the piston by the maximum force, and that of the water in the pipe by the air's pressure, are equal, viz. to 38 feet per second.

78. But when the maximum force is applied to the lever, the motion of the piston is thereby rendered so slow that there will always be a velocity of the water, from the pressure of air, greater than that of the piston at a less height than 30 feet. For admitting the pipe 30 feet high, and the air in its lightest state equal to a pressure of 32 feet of water, then the difference of two feet will generate an uniform velocity of water of more than 11 feet per second, which is many times more than that of the piston.

79. Hence it follows, that if two pistons be employed, they will not only have water enough, and to spare, but also keep that water in a constant uniform motion by their alternate action; but to answer this end, the water must rise in but one pipe, and be communicated at the top, by two separate valves, to pistons working in two different barrels placed in one common cistern EFGH.

80. To such a pump likewise a double lever MM may be applied to the wheel K, so that the pistons may be moved in a perpendicular direction on each side: at the two ends of this lever the men may stand in the best manner to work the pump; six, eight, or ten, as occasion requires. And thus we have at last arrived to the idea of a sucking-pump, which, as far as I am able to judge, will have all the advantages that such a machine is any ways capable of.

LIV. *Notice*

LIV. *Notice respecting the Expedition to New Holland, undertaken for the Purpose of making Researches into Geography and Natural History.* By A. L. Jussieu*.

Natural history is indebted for its most valuable collections and a part of its progress to zealous and enlightened travellers, who have abandoned their homes to traverse distant countries, often desert and little known. We preserve with gratitude and respect, in the history of science, the names of the French naturalists who at different epochs have enriched their country with foreign productions, either alive and now naturalized to our soil, or forming part of the collections made for public instruction. Some have written and published the fruit of their labours; others have fallen a sacrifice to the fatigue of a long passage, the intemperance of different climates, the attacks of savage tribes whom they visited with a friendly disposition, and sometimes the objects only collected by them have reached us: sometimes we have lost both the travellers and their collections, or we have been left in uncertainty in regard to the fate of both. Reverses of this kind have been more frequent than success. What interest, therefore, ought to be excited by these zealous men, who devote themselves to the dangers of such enterprises!

When government, in the year 8, ordered an expedition to New Holland, under the command of captain Baudin, for making researches in geography and natural history, a commission of the Institute was charged to select co-operators in this great labour, and to give them the necessary instructions. Persons well acquainted with each department, who to great knowledge united a decided taste for travelling, were made choice of. Every thing gave reason to expect a successful result; especially when among these travellers there were some who had participated, under the same chief, in the fatigues of a preceding voyage to America, and who did not hesitate to embark again under his auspices.

These combinations were deranged by some unforeseen circumstances. Several of these navigators were obliged by sickness to stop at the Isle of France; fear of being in want of provisions, and discontent, made several others remain behind; and when captain Baudin left that colony he had

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on board the two vessels only Messrs. Bernier, the astronomer; Boulanger, the geographer; Maugé, Péron, and Levillain, zoölogists; Leschenaut, botanist; De Pusch and Bailly, mineralogists; Riedlé, Sautier, and Guichenot, gardeners: Lesueur and Petit, who embarked in no particular quality, were substitutes for the draftsmen who remained at the Isle of France.

The first landings at New Holland, so much desired, were attended with danger, and had almost become fatal to several of the navigators. They were not, however, discouraged by this unfortunate commencement, and they anxiously embraced every opportunity of visiting these unknown shores. When the ships arrived with their fatigued crews at Timor, one of the islands of the archipelago of Asia, in the neighbourhood of the Moluccas, these naturalists, tired of being so long inactive, made haste to collect the productions of the place. Riedlé, the gardener, though scarcely recovered from an illness with which he had been attacked on the passage, employed himself too soon in the search of plants, with which he was desirous to enrich the garden of Paris; and he fell a sacrifice to a new relapse, after he had formed a pretty numerous collection. Maugé, the zoölogist, animated by the same zeal, neglected, in like manner, the care of his health in order to occupy himself in scarching for animals. He was scarcely restored when he was obliged to re-embark to go and visit the lands situated to the south of New Holland. In this part of the voyage the navigators obtained more precise notions in regard to several points of geography, and made numerous collections of animals and vegetables; but it became fatal to the zoölogist Levillain and the gardener Sautier, who, like Riedlé, fell victims to their zeal. Maugé soon followed them, and terminated his career at the Island Maria, near to Van Diemen's Land. He had been with Riedlé, the companion of captain Baudin, during his first voyage to America, and it was to their care united that the Museum of Natural History, to which they were both attached, was indebted for the numerous productions of the Antilles, with which its hot-houses and galleries were enriched in the year 6; and their loss was sensibly felt by all belonging to that establishment.

The two vessels, after passing d'Entrecasteaux's strait, on the coast of Van Diemen's Land, and visiting several of its ports and islands, were separated, and did not meet again till the month of Messidor, year 10, when they reached Port Jackson, in New Holland, where they received from

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the directors of that colony every necessary assistance for restoring the sick and in regard to a supply of provisions.

That part of the voyage made by the two vessels in company here terminates. Captain Baudin, being afraid that he should lose in a new voyage the live animals and vegetables collected by his own care and that of his fellow-navigators, resolved to put on board the Naturaliste all the collections already made by both ships, and to send them directly to France under the care of captain Hamelin, who had always had the command of that vessel since their departure from Europe. De Pusch, the mineralogist, whose health had been much injured, embraced this opportunity of returning to his native country; but, being too weak to bear such a long voyage, he was obliged to stop at the Isle of France, where he died after languishing a few months. Captain Hamelin, on approaching France, was examined by an English vessel, which, notwithstanding his pass, carried him into a port of England; in consequence of which delay he lost a great deal of time and many live vegetables. He arrived at Havre in the month of Prairial, year 11; his collection, being put into a boat on the Seine, reached Paris in safety.

Captain Baudin left Port Jackson at the end of Brumaire the same year with the Geographe and a small vessel better calculated for making observations, as it could approach much nearer to the coast. He had still on board Bernier and Boulanger, who assisted the officers in their astronomical and geographical labours. Leschenaut, who was the only botanist, was unwilling, though sick, to abandon the expedition. Péron, detained by the same motive, in order to make researches in zoölogy, which he was the only person who could follow, and in which he associated his friend Lesueur, become, by circumstances, a draftsman and naturalist; Bailly, who was to be occupied with mineralogy; Petit, charged with making drawings of the inhabitants, their dresses, habitations, and works of arts; and Guichenot, the only gardener, who endeavoured to increase the herbals, and to collect seeds and living trees.

This part of the voyage, in which the navigators carefully explored the southern coast of New Holland and some of the adjacent isles, as well as a portion of the western coasts, was attended with complete success. Several important points of geography were fixed, and a more considerable collection was made than that before dispatched to Europe. The captain himself had co-operated in the zoölogical researches, and especially those relating to birds.

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After a voyage of six months he touched again at Timor, to take in a supply of water, and to wait a favourable opportunity for entering the Gulph of Carpentaria; a minute examination of which was to conclude the labours of this expedition.

During this part of the voyage, which was fortunate in several respects, none of the naturalists died; but Leschenaut, too weak to continue his researches, was obliged to remain at Timor, from which he proceeded to Batavia, with a view of remaining there some time and then embracing an opportunity to return to Europe. Letters received from him by his family announce that, his health being restored by rest, he was enabled to make new botanical researches at Java, and was preparing to return.

Baudin, with his fellow-navigators, endeavoured to reach the gulph which he intended to visit; but after several fruitless attempts, buffeted by contrary winds, fatigued with his crew by continual labour; deprived of his astronomer Bernier, who died universally regretted, having been able to make only a few observations and small collections on different points of the northern coast, which is inaccessible; finding sickness to prevail in his ship, and being severely affected himself, he at length determined to proceed to the Isle of France, where he arrived in Fructidor, year 11, so much broken down that he soon breathed his last.

Captain Milius was charged to carry the ship to Europe with the new collections, increased by some live productions of the Isle of France. Having touched at the Cape of Good Hope, he took on board some live plants and animals furnished by the governor. After a fortunate passage the captain was desirous to enter the Loire, from which his collections might have easily been conveyed to Paris by water; but being opposed by the winds, and fearing that his plants might be injured by the cold, which already began to be felt on approaching the coast, he was obliged to land, in the month of Floreal last, at the port of L'Orient, from whence his collections were conveyed over land; but not without some loss, either in regard to the live plants or animals. One part of these objects, destined for her majesty the empress, were carried to Malmaison; the other was deposited in the Museum of Natural History.

Of all the collections which have reached us from distant countries at different periods, that brought by the Naturaliste and the Geographe is certainly the most considerable, especially in regard to the animal kingdom. That of the Museum has been augmented by a great number of new species,

species collected in the course of the expedition, and the science of natural history has gained in the same proportion. It is our duty to present here a short view of these acquisitions, in order to give to government and men of science some idea of the advantages arising from an undertaking which had been considered unfavourable, and in order that we may pay those laborious men who surmounted so many obstacles for the purpose of collecting these scattered objects, that tribute of esteem and gratitude which is owing to them by the nation.

It will not appear astonishing that, in researches confined to coasts for the most part desert or covered with woods, which presented neither high mountains nor ravines where the different strata could be observed, or where mines could be dug, the mineralogists Pusch and Bailly should be able to collect only a small number of minerals, insufficient to give an accurate idea of the geology of the country. What they brought home will serve at any rate to convey a general notion of the surface of the districts which they visited, and to indicate the distinction of the epochs at which the mineral substances found in them were produced.

In botany, numerous collections, formed with great care, of live and dried plants, seeds and fruits, and of specimens of wood, were begun by Riedlé and Sautier, and continued by Guichenot, who alone remained behind them. Leschenaut rendered important services by collecting, describing, and delineating himself more than 600 species which he believes to be new, and of which several may constitute new genera, and perhaps orders. The most important researches were made on the south-west coast of New Holland, and in touching at Nuyt's Land, Lewin's Land, Endracht and Edel's Land, regions for the most part never visited by the English. Seeds carefully collected by the botanist and gardener, which were sown at Malmaison, in the garden of the museum at Montpellier, and other parts in the south of France, and most of which have been raised, afford hopes that some productions of that part of the world may be naturalized in France. We shall mention here the flax of New Zealand, which unites the brilliancy of silk to the strength of hemp; the *casuarina* wood and the *xylomelum*, superior for cabinet-work to many of those kinds now employed; the English cedar; the *eucalyptus*, which rises to the height of 150 feet, has a trunk 24 feet in diameter, and which produces an odoriferous resin that may become a very valuable medicine. All these new plants, which have germinated in our climate, when habituated to it may indemnify

demnify us for the loss of a part of the plants which had been transplanted and carefully arranged in a hundred boxes, each of which contained fifteen or sixteen live plants. In the last place, an herbal of 1500 species, the specimens of which multiplied, and in good preservation, afford to botanists the means of enlarging this part of the science.

The European nation, who inhabit a point of New Holland, may, however, rival us in researches respecting the vegetable kingdom, to which several of our men of science devoted themselves; but in general they have neglected the department of birds, of which at present we possess a very numerous series, begun by the unfortunate Maugé, enriched with some articles by Baudin and Levillain, but for which we are in particular indebted to the assiduous care of the young Péron and Lesueur, inseparable friends, who mutually assisted each other. The former, who remained the only zoölogist of the expedition, did not attend merely to physical and anatomical observations, to which he at first more especially devoted himself; he embraced also with zeal the other parts of zoölogy. Lesueur, charged only with delineating animals, thought it his duty to add to this function that of collector: and Péron acknowledges that he was much indebted to this faithful companion, who sometimes explored the coasts or penetrated into the country with him; sometimes remained on board the vessel, prepared and made drawings of the objects collected by his friend, to shorten his labour and enable him to engage in new researches. The number of animals they brought home is considerable, and many of them are absolutely new. Péron wrote descriptions on the spot of a great number of them, according to a new and uniform method, which embraces the organization, manners or habits, names and usages of the country. This collection contains some of those shell-fish which form the principal nourishment of some of the inhabitants of Van Diemen's Land; a numerous series of holothuria, marine animals, which in India are accounted delicious food, and for that reason are a valuable article of commerce; various quadrupeds, which might be easily naturalized in France; and in particular several species of kangoroos, whose fur is good, and their flesh excellent; the phascolome, also good to eat, and which might be easily domesticated; the cassoary of New Holland, alive in the museum, the flesh of which, participating in that of the turkey and pig, might be agreeable food; the black swan, existing in the museum, which, on account of its

its tender flesh and very fine down, might be rendered useful in our court-yards, at the same time that it would contribute to the ornament of our pieces of water; the pheasant with a tail like a lyre, which on account of its form and the beauty of its plumage might shine alongside our European peacock. Passing over other useful animals, we shall terminate this article by an abridgement of the report of the professors of the museum, who each in his department made out a list of this zoölogical collection, presenting here, under the form of a table of three columns, the number of individuals brought home, that of the different species, and an indication of those which are new:

Classes of Animals.	Number of Individuals.	Number of Species.	New Species.
Mammalia - - -	125	68	32
Birds - - - -	912	289	144
Quadrupeds and oviparous bipeds - - -	234	60	41
Reptiles - - -	53	38	26
Fish - - - -	592	340	185
Crustacea and arachnides	414	153	134
Echinodermata - -	686	280	241
Testacea - - -	10,000	1232	640
Worms - - -	304	34	28
Insects - - -	4218	1043	880
Zoöphytes - - -	876	335	191
	18,414	3872	2542

According to this table, therefore, the zoölogical collection of the museum has been enriched with 2542 new species, and a great number which were wanting among the 1330 already described in some works. Besides, science has acquired more than 2500 unknown objects, many of which will form new genera, and perhaps orders. The considerable number of duplicates will enable us to procure by exchange objects which may still be wanting in the general collection, or to augment those which exist in the principal cities of the empire. We shall add, that 960 drawings by young Lesueur still attest his zeal and activity.

LV. *Che-*

LV. *Chemical Researches on Vegetation.* By THEODORE DE SAUSSURE. *An Extract read in the French National Institute by* L. BERTHOLLET *.

THE class charged me to give a verbal account of a work presented to it by Theodore de Saussure, entitled *Recherches Chimiques sur la Végétation*; but the important results of these researches have induced me to present to it an extract which may enable it to judge of the progress for which the theory of vegetation is indebted to this author.

Senebier, whose name occurs so often in the history of the physiology of vegetables, Gough, Rollo, and Woodhouse, had observed that seeds could not germinate without the contact of oxygen gas, and that germination is accompanied by a production of carbonic acid. Saussure mentions the experiments he before published, and which, indeed, prove that in this effect the volume of the oxygen gas is not altered, but that it is only changed into carbonic acid; whence it results, that in germination a seed loses a part of its carbon, by means of the oxygen gas which combines with it retaining the elastic state.

If the seed which has germinated be afterwards dried, it is found that it loses a weight very much superior to that which arises from the extraction of the carbon; whence Saussure concludes that there is separated also during the desiccation water, or a corresponding proportion of hydrogen and oxygen, which greatly surpasses the weight of the carbon which has been disengaged: a consequence of this observation is, that notwithstanding the loss of the carbon it experiences in forming carbonic acid, the seed which has undergone desiccation after germination is found to have a greater proportion of that element than if it had been dried before it experienced germination.

The carbonic acid gas, which is a product of germination, becomes itself an obstacle to its progress; so that, if carbonic acid be mixed with the air which is in contact with the seed, the germination is rendered more feeble than by a similar mixture of azotic gas or hydrogen gas.

Water charged with carbonic acid is equally contrary to the development of the seeds put to germinate in it; but, if they have passed the period of germination and attained to that where vegetation begins, the carbonic acid becomes an useful agent, under conditions which, as they have not yet

* From *Annales de Chimie*, No. 150.

been

been determined by observations, have produced uncertainties and even contradictions in the consequences deduced from them. Saussure shows that a twelfth of carbonic acid gas added to the atmosphere in which vegetation takes place, is favourable to its progress; that a greater proportion is prejudicial; that the substances which can furnish this quantity of carbonic acid, by their contact with the atmosphere in which the plant lives, produce an advantageous effect without having an immediate communication with the plant, and that the benefit arising from the carbonic acid takes place only when the atmosphere contains a greater or less proportion of oxygen gas, otherwise it becomes hurtful.

Atmospheric air which has been deprived, by means of lime, of the carbonic acid it contained, continues proper for maintaining vegetation in the sun; but if lime be placed in a receiver filled with atmospheric air, and in which the plant is exposed to the light, the plant soon perishes, and the lime has absorbed the carbonic acid. It is seen, then, that during vegetation there is formed carbonic acid, but that this acid ought to serve for maintaining the act of vegetation; for if it be absorbed vegetation ceases. This effect takes place whether the plant be kept in water or whether its root be in the earth; only in the latter case the effect is less, because a part of the carbonic acid arising from the root is more abundant, and is not soon enough absorbed by the lime. In the shade, the presence of lime instead of being hurtful is favourable to vegetation, because in the shade the carbonic acid is as contrary to vegetables as it is favourable to their development with the aid of light.

Dr. Priestley discovered that leaves ameliorated air which had been corrupted by combustion and respiration. Senebier had shown that this phænomenon arose from the property which leaves have of decomposing the carbonic acid by appropriating to themselves its carbon and eliminating its oxygen. This important discovery required that the effects of the decomposition of the carbonic acid, and the changes which result from it, either in the atmosphere in which a plant is maintained or in the composition of that plant, should be more particularly analysed. This is what Saussure has done.

He shows that the atmosphere, of which carbonic acid forms a determinate part, and in which a plant vegetates in the light, does not generally change its dimensions, though it sometimes experiences a little diminution; that the carbonic acid is destroyed, and is replaced by oxygen gas; but that this replacement is not total, being equivalent only to half

half that which formed the carbonic acid; that the complement of the volume is owing to the azotic gas which is exhaled from the plant.

When the carbonic acid, then, is decomposed, its carbon and a half of its oxygen enter into the composition of the plant, from which there is exhaled a variable quantity of azotic gas.

Saussure, indeed, has confirmed that plants which had operated a decomposition of carbonic acid give more carbon than before that decomposition; those, on the other hand, which are made to vegetate in distilled water and an atmosphere deprived of carbonic acid, make no acquisition of carbon.

It was experiments, probably, made under this circumstance which gave reason to conclude that plants which vegetate in pure water and in the open air contain no carbon but that found in the seeds from which they were produced. But Saussure has ascertained, by repeated experiments, that plants exposed to the open air acquire pure carbon by the decomposition of the carbonic acid naturally found in them.

It had been observed that vegetation produced under different circumstances a dilatation or contraction of the atmosphere in which it is effected. Saussure shows that the leaves absorb oxygen gas in darkness, and that they emit an equal quantity when exposed to the light; so that the same atmosphere deprived of carbonic acid is, according to common language, corrupted in the night and purified during the day. He denotes this alternate phænomenon by the words *inspiration* and *expiration*, and establishes the relation of these vegetable functions according to the kind of plants and according to the circumstances under which they exist.

The oxygen gas which has been inspired is changed into carbonic acid; the latter is decomposed in the act of expiration, and abandons the half of its oxygen, which resumes the elastic state.

The roots, wood, and petals, perform no inspiration; but they give up carbon to the oxygen gas which surrounds them, and at the same time there is a production of water: green fruits, however, and the young bark which is still green, enjoy inspiration, and produce a compound effect on the atmospheric air.

Having examined the relation between the living vegetable and the atmosphere, water and the carbonic acid, Saussure submits to the same examination vegetable substances deprived of life.

Extracts of vegetables placed in the air gradually deposit in it pellicles less soluble; during this alteration the oxygen of the atmosphere is changed into carbonic acid; but the volume of the latter undergoes no change, or experiences that only which arises from the absorption of the carbonic acid which is formed; at the same time a part of the oxygen and hydrogen which enter into the composition of the vegetable substance forms a more intimate combination, and is reduced to water; so that the extract loses much less of its weight by this production of water than by the carbon separated from it, and there is found a greater proportion of carbon than before this formation of carbonic acid: we have before remarked other circumstances in which a double effect takes place during vegetation.

Dead wood produces the same effect on the atmosphere, and undergoes the same production of water: when deprived, by repeated decoctions, of all its soluble part, and exposed to the air, it changes the oxygen gas of it into carbonic acid; its own oxygen and hydrogen form water; it then gives a new extract in the water in which it is boiled, and by means of its successive losses acquires a superabundance of carbon. It had been observed that in the acetification of wine there is an absorption of oxygen gas, and this oxygen absorbed had been considered as the cause of the acidity which is developed; but Saussure has ascertained that the oxygen gas is merely changed into carbonic acid, and that there is no other absorption than that of the carbonic acid formed: the production of acidity can therefore arise only from the excess of oxygen which becomes prevalent when a part of the hydrogen has produced water.

The case is not the same with the epoch at which, by the progress of alteration, the vegetable substances placed under water disengage inflammable gas: they can then absorb oxygen gas, which in all probability produces water.

Oils form another exception: they really absorb oxygen: the author was not able to ascertain whether there was a production of oxygen, or whether the oxygen combined with the oil. He has not yet cleared up what takes place in the transition of oil to the state of resin.

Azotic gas is not affected by vegetable substances, except by some oils which absorb a small quantity of it, but which retain it only weakly.

Vegetables exposed to the action of the air and of water are at length reduced to a black substance which Saussure distinguishes by the name of *terreau* (vegetable mould): preceding experiments show that this substance is not the result

result of the combination of oxygen gas with the dead plant, but that it is the residuum of the subtraction of the elements of the vegetable which have served to the production of water and carbonic acid.

It was of importance to compare the different vegetable moulds with each other, and with the substances which had not experienced destruction, to establish afterwards in what manner they might serve for reproduction.

Vegetable mould is an uniform substance, which seems to differ only by a greater or less proportion of the soluble part in water.

It contains a greater proportion of carbon than the plants from which it arises; and we find here a consequence of preceding observations, which show that dead vegetables acquire by their action on atmospheric air a greater proportion of carbon, in consequence of the production of water which takes place, than they lose by the formation of the carbonic acid.

The proportion of carbon, however, in vegetable mould, when it attains to a certain point of decomposition, does not increase by the continued action of the causes which produce it: brought into contact with air, it continues to form carbonic acid, and to produce water by the union of the oxygen and hydrogen it contains: but the latter production is less considerable than before that epoch; the elements which are separated by this ulterior destruction are in proportions corresponding to those which form the residuum, so that the vegetable mould continues to be destroyed without the residuum changing its nature.

The vegetable mould retained all the principles which are found in the ashes of vegetables; but these substances resist the proofs to which they are directly subjected: it is only in the ashes resulting from their combustion that one can distinguish them: moreover, a semi-vitrification may prevent the potash from being dissolved by the water; it is only by more energetic means that it can be separated.

This series of researches has induced the author to determine the quantity of carbon furnished by a great number of vegetable substances: he took the most proper precautions to obtain uniform carbon, and to fix the proportions: he was obliged to neglect the part which is disengaged in a gaseous combination; but this disengagement ought not to occasion any sensible difference between the comparative quantities of the carbonaceous residuum.

Having analysed the phænomena of vegetation which depend on the action of light, or the privation of it, in at-

mospheric air, the author examines those it exhibits when green plants are placed in azotic gas, hydrogen gas, and in *vacuo*.

Plants provided with their green parts seem to be those only which can vegetate in mediums deprived of oxygen gas, because they diffuse through them this gas. When it is taken from them, in proportion as they produce it their development is checked; they absorb neither azotic nor hydrogen gas; they vegetate in *vacuo* as in azotic gas, provided the experiment is made under shelter from the direct action of the sun's rays. Plants show a great difference in these phænomena according to their epochs.

The author then proceeds to examine a very important question in vegetable physiology, that of the fixation and decomposition of water.

He shows that plants appropriate to themselves the oxygen and hydrogen of water by making it lose the liquid state; but this assimilation, he says, is not very striking, except when they become incorporated at the same time with carbon.

To establish this assertion he placed plants in water, leaving no carbonic acid in their atmosphere; they acquired a very considerable weight, but they lost nearly the whole of what they had acquired by desiccation in the open air: on the other hand, when the vegetation was assisted by the decomposition of the carbonic acid, the weight which they retained after desiccation far surpassed that which might have arisen from the carbon abandoned by the carbonic acid.

From this observation he concludes that all the oxygen gas dispersed throughout the insulated atmosphere when the green plants are exposed to the light, arises from the decomposition of the carbonic acid.

I shall venture also to defend an opinion which differs very little from that of Saussure and Senebier, and which appears to me to throw more light on the phænomena of vegetation.

The immediate effect of light is the production of the green juice of the leaves, which then undergoes various changes in the plant; but the green part arises from a resinous substance, as has been shown by Rouelle: it cannot be doubted that a resinous substance contains hydrogen which is not in a state of saturation. The water, then, must be decomposed in a plant which is supplied with no other aliment than the water in the insulated atmospheric air, if it acquires there a green colour.

During

During the desiccation in the open air of plants which have lived without carbonic acid, there must be formed carbonic acid, according to the experiments of Saussure, an abstract of which I have here presented, and water must be produced at the same time; since, instead of losing any of their primitive weight, they make, on the contrary, a small acquisition; an increase of the vegetable substance, not owing to a mere fixation of water, and which is greater than that announced by the balance, must have taken place before the desiccation.

When plants live in the light in atmospheric air, or in any other gas deprived of carbonic acid, they give out a little oxygen gas: according to Saussure, this oxygen gas is changed during each inspiration into carbonic acid, and is again decomposed; but the carbonic acid in its decomposition retains one-half of its oxygen: it thence follows that in each expiration the proportion of the oxygen gas ought to decrease, did not the decomposition of the water furnish a supplement.

It appears to me, then, that in common vegetation the water and carbonic acid are decomposed simultaneously by the action of the light; that the result of this decomposition is, on the one hand, an emission of oxygen gas, which cannot be ascribed to the one more than to the other; that, on the other hand, there is formed a vegetable substance which is inflammable, because it contains an excess of carbon and hydrogen on account of the emission of the oxygen with which they were saturated; and that when a plant is deprived of carbonic acid it may still be supported, or make some progress, by means of water alone.

Having insulated the act of vegetation to discover its essential conditions, and to deduce from them the principal results, it was necessary to examine the circumstances of common vegetation to determine its particular effects, and especially to go back to the origin of the substances found in plants, and which cannot be owing to oxygen, hydrogen, and the carbonic acid.

This part of vegetable physiology stood so much the more in need of being explained, as observations which exhibited an imposing appearance of exactness had conducted to suppositions which could not be reconciled with physical theories. "Tull, Van Helmont, and even some modern naturalists," says Saussure, "have endeavoured to show that vegetables do not draw water from vegetable earth, and that manure acts on the soil only by furnishing to plants a maintenance

maintenance more or less proper for retaining heat and moisture: these authors have supposed that the vital force, both animal and vegetable, might, by decomposing or combining in different ways atmospheric air and water, produce all the substances, and even the salts, earths, and metals, which are proved, by analysis and incineration, to exist in vegetables. This confused idea is not more susceptible of being proved than that of making gold from substances which contain none of it. Before we have recourse to unintelligible transmutations, miraculous, and in opposition to all the observations known, we ought to ascertain exactly that plants do not acquire and find these principles ready formed in the mediums in which they expand."

This part of the work contains a great number of new observations and happy comparisons between experiments and agricultural observations; but I shall confine myself to general results.

Roots and plants absorb salts and extracts, but in a less proportion than water which holds these salts and extracts in solution.

The salts which the roots have absorbed are found in plants without any change in their state of nature.

It is to be wished that the author would extend his researches on the formation of the acids which seem to be the product of vegetation; such as the oxalic acid, the citric, and the tartarous.

A vegetable does not absorb in the same proportion all the substances contained at the same time in the same solution; it forms particular secretions of them: thus, in a solution of different salts the roots take up more of one kind than of another; in general they absorb in greater quantity the substances the solutions of which, when separated, are less viscous.

When we compare the weight of extract which can be furnished by the most fertile soil with the weight of the dry plant which has expanded in it, it is found that it could have derived from it but a very small part of its substance.

Saussure proceeds to examine the ashes which vegetables leave by combustion. He proves that all the predominating principles in ashes are contained in the vegetable mould, and that its soluble part, which alone penetrates into the vegetable, contains these principles in a greater proportion than the insoluble part: their existence in the plant, then, has nothing natural, as he observes, and their absence in it would excite more astonishment.

Plants

Plants made to vegetate in water and in a confined atmosphere, give only the same quantity of ashes which would have been obtained from their seeds; but in the open air they acquire a small quantity, which must proceed from the bodies floating in the atmosphere.

Ashes are composed of saline parts soluble in water and of parts insoluble: the proportions of the insoluble and soluble part vary according to the soil, according to the circumstances of vegetation, and in the different parts of a plant: ashes are more abundant as the vegetable substance is more distant from the ligneous state; but they contain the more soluble substance as they have been less subjected to the dissolving action of the water; so that a vegetable abandons the soluble salts it contains when exposed to the action of foreign water: I regret that the author did not examine the salts which the water may in this manner take from vegetable substances, in order to ascertain in what state of combination is the potash which becomes free during incineration.

The author found phosphates in all the vegetables the ashes of which he examined: the phosphate of lime forms often the greater part of the insoluble portion; but that which is soluble contains sometimes phosphate of potash, or a triple combination of phosphoric acid, potash, and lime: on this occasion he examines that triple combination, which may differ by its proportions and by the effects which chemical re-agents produce in it: ashes contain scarcely any magnesia and alumine. These results, with which several others are connected, are established by seventy-nine experiments on incineration, to each of which is added a corresponding analysis. The methods of analysis followed are carefully described.

I have been able to give only a short view of this immense labour, which must add to the celebrity of the author.

LVI. *Memoir on the Natural History of the Coco-nut Tree and the Areca-nut Tree; the Cultivation of them according to the Methods of the Hindoos; their Productions, and their Utility in the Arts and for the Purposes of domestic Economy. By M.* Le Goux de Flaix, *an Officer of Engineers, and Member of the Asiatic Society at Calcutta**.

These interesting vegetables are indigenous in the East Indies: they are found also in some parts of Africa, and even of America; but I do not think that they were placed there by nature.

Travellers have given descriptions of these vegetables, which are the delight of the natives, and serve to ornament their habitations; but they appear to me to be in many respects incorrect. I shall therefore describe them as I observed them during a long series of years, and in different countries of Hindostan. I shall begin with the coco-nut tree as being the most useful, and shall then speak of that which bears the areca-nut.

It is well known that the coco-nut tree (*Cocos nucifera* Linn.) is of the genus of the unilobe plants, of the monoecia hexandria, and the family of the palms, to which botany has given this appellation because instead of boughs and branches they bear palms. The coco-nut tree exhibits also as characters a flower-bud or sheath, which is monophyllous, and a branchy palm winged and exceedingly long. Its bud is furnished with a very great number of branches attached to a pedicle exceedingly short. It presents also a very great number of flowers about two or three lines in length, oblong, with a corolla of six equal petals horned, convex, rounded at their extremity, of a pale flesh colour, and having little odour. These flowers, the males of which are placed above, have six stamina with sagittated antheræ, and a pistil which miscarries: the female, which are more numerous, placed near the former and along the same stalk at intervals of five or eight, have a round ovarium destitute of a style, and over it a three-lobed stigma.

Some of the flowers before the *spatha* opens are succeeded by a drupa, at first exceedingly tender, round, and whitish, which becomes very large, smooth, coriaceous, and fibrous: it contains a nut more or less oval, monospermous, exceedingly hard, of a brown colour, sometimes veined, of one piece,

* From the *Bibliothèque Physico-Economique*, Nos. 5, 6, 7, &c. 1804.

piece, marked with sutures which form a ridge sometimes more and sometimes less prominent: it has in its lower part a hole called the *eye*, through which the germ issues: it exhibits also the figure of two more; which may have made some naturalists, deceived by the appearance, imagine that it has three.

In the East Indies there are known seven different species of the coco-nut, without comprehending that called, improperly, the *sea coco-nut*, and which naturalists believe to be indigenous in the archipelago of the Maldives, though it grows only in the Sechelle isles. This coco-nut forms a particular species very distinct from that cultivated either in Hindostan, in the other countries of the East Indies, or in the islands of the Asiatic seas. I make use of the word *species*, and not *variety*, that I may expressly conform to the signification of the word received in botany to denote those individuals which always retain the same configuration.

No distinguishing characters between the species here mentioned can be drawn either from the palms, the sheaths, or the flowers of the vegetable, their figure and form being absolutely the same. These characters can be taken only from the configuration of the fruit, which never varies and never changes in whatever country or soil the tree may be cultivated. As no naturalist who has travelled in that part of the world where this useful and beautiful tree grows has described these species, I shall supply this deficiency by exact descriptions taken from their proper characters after a number of observations, and I shall leave it to masters in the science to denominate and designate them in their synonymies.

There are three kinds cultivated in Hindostan; four more are cultivated in the isles of the seas which lie adjacent to this country, rendered so rich by its productions, by the industry of its inhabitants, and by the mildness of its climate.

1st, *The coco-nut of the coast of Coromandel* exhibits a husk very smooth and shining, of a reddish yellow colour, on which account it is called by the Hindoos the *Bramin coco-nut*, because it approaches near to the colour of the skin of the individuals of that cast. The sutures opposite to the side on which the eye is placed are more swelled towards the base, a part which is also more flattened than that opposite to it even when enveloped in its husk.

2d, *The coco-nut of Canara*, a country situated between the two branches of the double chain of the Gauts, very high mountains which extend through the peninsula of India

India from south to north, and divide it into three zones in its whole length. This species has for distinguishing characters a form perfectly oval, a ligneous and more solid shell, a husk exceedingly green, and filaments remarkably hard, all its sutures so little prominent that they are sensible to the eye but not to the touch.

3d, *That of the coast of Malabar*, which is turbinated; that is to say, larger at the hole which is found under the covering that binds and fixes the pedicle of the fruit to its cluster.

4th, *The coco-nut of the Maldives*, sandy islands, uncovered, no doubt, by the sea at no very distant period, is very small and absolutely spherical; its sutures are very much raised, and far more prominent in the upper part than those opposite to its pedicle.

5th, *That of Achem*, a small island situated on the south side of those of Sonda and the Moluccas, is distinguished by its ovoid form, its extreme smallness, and the thickness of its kernel, which is so pulpy that there is scarcely any vacuity in it, and that it contains very little liquor.

6th, *The species cultivated in the Nicobar Isles*, situated in the upper part of the Bay of Bengal, which is the largest of all the varieties of this fruit. Its external form is triangular; its husk or fibrous bark is remarkably thick; the nut is oval, and a little flattened at its two poles, and there issues from the upper pole a sharp point; on which account it is called the *needle coco-nut*.

7th, *The coco-nut of Ceylon* is a very elongated spheroid: it has its suture corresponding to the orifice or eye of the germ, more prominent by a strong line than those of the other countries. Such are the characters which distinguish the different species of the coco-nut of the Indies.

The utility of the coco-nut has been so well known in Hindostan since the remotest antiquity, that Brahma, of whom the Indians call themselves the children, the legislator of that country at a very remote period, marks out one of the nineteen casts which compose that people for the purpose of being exclusively occupied in the cultivation of this valuable tree, and in extracting and preparing the different products of it. This cast is that of the *Chanas*; it is one of the highest and most distinguished, and one of those said to be *of the right hand*. In a word, this tree is so valuable in the eyes of the Indians that they consider it almost as an unpardonable crime to cut it down: according to them it is a sort of homicide; an idea, in some measure, well founded, as I shall here show. This opinion

characterizes, more than any thing that could be said, the mild and humane disposition of the Hindoos.

The coco-nut tree, indeed, has some resemblance to man. Its development does not take place, like that of other trees, by ligneous strata placed over each other; the trunk is composed of an infinite number of needles of greater or less length, all united and bound together in bundles by a tender and spongy pith which surrounds them. It grows only by the successive development of its palms, all issuing from the body of the tree, which when the plant dies is speedily reduced to dust. This observation, which is very exact, destroys the assertions of most naturalists, such as Thunberg, Rumphius, &c., who have said that the wood of the coco-nut tree is hard, and fit for a great number of domestic purposes.

I shall now give a short view of the methods of culture employed by the Hindoos to rear and propagate this useful and beautiful palm, and to make it yield that liquor or wine which distils from the *spatha*; I shall describe the use they make, either for food or in the arts, of the fruit, the leaves, and the liquor of this vegetable; and I shall speak of the different processes which ought to be pursued in order to obtain from it its different products; details as interesting as curious, which no traveller has ever yet made known, at least in so particular a manner as to satisfy curiosity, and to convey an accurate knowledge of this palm to those who may be desirous of cultivating it, and of deriving from it all those advantages it is capable of affording.

The coco-nut tree is called *phexiana* in the Shamskrit, the primitive language of the country. It is named *tenemaron* in the idiom of Ceylon, and in almost all the dialects of that part of India called by the Hindoo geographers the *Decan*; that is to say, the southern part, described, very improperly, by the Europeans as a peninsula, under the name of the *Peninsula on this side the Ganges.*

Of all the great family of the palms it is that which attains to the greatest height. It has a majestic and agreeable appearance: it generally rises to the altitude of fifty feet, and its common duration is eighty-five years: it never exceeds a century. Its growth is quicker till it attains to the age of thirty-five years; when it reaches that period its development is slower: from its fiftieth to its sixtieth year it produces less; its beautiful and verdant crown loses its colour, becomes thin, and its development till its death is almost insensible. At that age it has all the characters of the decrepitude of man; its leaves grow yellow and drop; and if

by any accident it loses its top, which the Hindoos very expressively call its *head*, the roots cease to acquire nourishment, and the trunk is reduced to dust in the course of eight or ten days. It is with reason, therefore, as I have already observed, that the Hindoos find some relation between this tree and animated beings; or, in a word, with man. In this respect it is very different from other large vegetables the wood of which survives their destruction; and it is for this reason that the antients, like the Hindoos in regard to this palm, personified trees under the name of Fauns, Satyrs, and Sylvans.

The coco-nut tree is reproduced only by the fruit. It is planted in nurseries at every season of the year. The soundest fruits, and those which are not cracked, must be chosen. They must not be stripped of their first fibrous covering, which the Indians call *kaer*, and of which they make excellent ropes. They have found that water and this substance are necessary to facilitate the germination of the seed, which takes place about the seventeenth or eighteenth day.

The nut must be placed lengthwise a little inclined, and turned in such a manner that the eye from which the germ issues may be towards the surface of the earth, so that its rising stem as it shoots up may not incline, and be obliged to bend itself in order to issue from the earth.

Immediately after the nursery has been planted, and each coco-nut has been covered with five or six inches of earth, which is not trod down, the plantation, which is made of a square form in order to facilitate irrigation, is watered. This is the best method of supplying it with moisture. A watering-pot would displace the earth, or form it into masses; inconveniences which must absolutely be avoided. The Hindoos continue to water the nursery every two or three days, according as the air is more or less dry, during six weeks or two months. Water, according to the Hindoo agriculturists, is the only or at least the principal cause of vegetation: it is indispensably necessary to germination, to the existence of this palm, to its strength and its preservation, especially in its youth.

About the eighteenth or nineteenth day the point of the germ is observed issuing from the earth like the small tooth of an elephant, and as white and smooth.

This point of the nascent coco-nut tree, like that of almost all the palms, retains this form for a fortnight or three weeks. It is then exceedingly tender, saccharine, of an agreeable taste, and exceedingly delicate to eat either raw or

or roasted in ashes. It is often presented at the best tables of the Europeans. The Hindoos, who are frugivorous, make ragouts of it under the name of *cari*. To this point they give the name of *kelingue,* which signifies *the first shoot of the palms.*

The first leaf begins to show itself only on the thirty-fifth or fortieth day. It appears like a bundle of small ribbons, shaded with pale flesh colour, and bordered with a band of beautiful green.

The roots first begin to be formed in the woody cod, the second covering of the coco-nut, in filaments, united in groups, shaped like a very large goose egg, of a yellowish colour, tender, and saccharine, which are eaten, prepared like the *kelingues,* as well as the young leaves, which we call the *cabbage of the coco-nut* tree, and which in delicacy of taste surpasses the finest almonds. Assisted then by moisture and heat, they burst about the thirtieth day, on all sides, that shell which preserves the fruit for years, which secures the nascent roots from the attack of destructive worms, and which, by its great solidity, prevents the evaporation of the water inclosed in the shell, as well as the desiccation of the milky juice of the pulp or kernel necessary for the development of the germ, and of the roots of the vegetable. The roots, when become strong, about the third month, penetrate into the earth all around the palm, and take hold with such force, that the greatest efforts are necessary to tear them up. Hence, a coco-nut tree can with difficulty be overturned by the most impetuous storm.

The wood of the coco-nut tree is not hard, but it is exceedingly flexible and pliable during the time that it vegetates or retains its sap. It has then such elasticity, that a cannon ball rebounds, and is reflected from it. A military officer, in the service of the French East India Company, who in the year 1760 commanded fort Alemparne, the revetemens of which could not have stood ten cannon shot, endured a siege of ten or twelve days, because M. Verri, who had the command there, conceived the idea of causing the faces of the walls to be covered with coco-nut trees, suspended from them. Another proof of my assertion, in regard to the astonishing elasticity of the wood of the coco-nut tree, occurred during the memorable siege of Pondicherry, in 1778: a ball fired from the place accidentally struck a coco-nut tree in an avenue opposite to it, and perforated the body of the tree, which bent, and suffered it to pass through it, as if it had gone through a mattress. The trunk then closed up, bringing together all the lig-

neous

neous needles of which it was composed; and at the time the place surrendered the wound was perfectly healed.

I mention these facts that advantage may be taken of them, should urgent circumstances render temporary fortifications necessary in a country where coco-nut trees can be readily obtained. I was sensible of the utility of it during the siege of Pondicherry, in 1778, at which time I caused the merlons of the ramparts to be covered with it.

It is not till the end of the fifth month that the first leaves of the coco-nut tree make their full appearance. Their alæ are still adherent, and all united as if cemented together. The case is the same with all those which shoot out till the twelfth or thirteenth month; they all issue from the centre, that is, from the head or crown of the foliage, and are supported by a kind of tissue exceedingly strong.

If all seasons are propitious to the planting of this tree, they are all equally suited to it when transplanted to the place destined for it. Every kind of soil, even the most sandy, agrees with it, provided it is not suffered to want water; it even thrives better in light than in strong soil. The cultivation of this vegetable proves, in a decisive manner, the justness of the agricultural principles of the Hindoos, that water alone contains all the nutritive parts of plants. In this respect my observations induce me to entertain the same opinion; it is founded on a number of trials made during a series of years, on more than fifty species of gramineous plants, shrubs, and trees, which I cultivated in water only, keeping them in vessels proportioned to their strength. These facts are incontestable, and can be proved by many persons, both French and English, who were witnesses of them, and came to see them in my garden at Pondicherry, between the years 1771 and 1784.

The coco-nut tree is generally transplanted from the age of eight to fifteen months. It may without any inconvenience be removed at the age of two or three years; but in this case it requires more caution, to prevent the roots from being broken, as they would not grow again; an accident which would infallibly cause the plant to die.

It succeeds equally when planted in groves, in orchards, or when destined to form avenues, or to ornament walks in a garden; it produces a beneficent shade; and its roots, which do not extend far, can hurt no vegetable, though even so near as almost to touch it; nor does it injure walls, near which it may be planted. All these reasons induce the natives of India to place it around their habitations, and always as near them as possible.

Its

Its numerous palms, which are from eighteen to twenty-four feet in length, become interwoven, and cross the branches of other trees in the neighbourhood, without hurting them, or impeding their mutual vegetation. The sea may wash the bottom of coco-nut trees without injury; for, instead of suffering from the salt water, they acquire more vigour, and produce with more fecundity. This observation will occur to those who travel along the coast of Malabar, which is covered by an immense and thick forest of these palms, and exhibits the most delightful and picturesque scenery.

This observation leads me to speak of a practice followed by the agriculturists of Hindostan, as well as by those of China, and of other countries, comprehended under the general name of India. They are all accustomed, when near the ocean, to water their rice fields with sea water; or, when at a distance from it, they besprinkle them with salt before they are tilled; and they generally follow this practice in the cultivation of all the esculent or leguminous plants produced in their country. During my travels through the interior parts of India, and even the most northern districts of that vast empire, I have seen immense fields covered with other kinds of gramineous vegetables, the soil of which had been manured only with leaves, salt, and the ashes arising from plants, and the remains of the straw of the former crop, preserved for that purpose, and burnt standing.

Salt, ashes, and water, then, are the only manure employed by the Indian agriculturists to improve their lands; the remains of plants and noxious weeds being burnt in this manner, it is never necessary to suffer the fields to remain fallow. These agricultural practices, followed for ages, by men who are the inventors of all the arts and all the sciences, and who are the most skilful in agriculture, as is proved by the perfection to which the cultivation of land has been carried in Hindostan, are an evident proof that dunghills are not so necessary to the success of crops as is generally imagined in Europe. I shall here add, that the fields in all the districts of this immense country, where this method is followed, never remain fallow, and produce two, three, and even four distinct crops in the course of the year. I could not help introducing these observations in this place, though they do not belong directly to the subject in question.

The coco-nut, which retains its germ for years, when preserved from humidity, will germinate, however, without

being put into the earth. It is sufficient to heap up a certain quantity of them, and to moisten them, that the husk may not become dry. It is in this manner they are prepared when oil is to be extracted from them by pressure.

When transplanted, all the pits are dug to the depth of from twenty to twenty-two inches, and of an equal breadth; the earth is then suffered to dry, and a stratum of salt, five or six inches in thickness, is put into the bottom of each pit, and on this is placed the young plant. Great care must be taken, when advanced in age, to transplant it with all its roots and the earth they retain; but when transplanted at a favourable period, that is to say, at the end of a year or fifteen months, it will be sufficient to dig up the earth with a hoe around the young plant, to disengage the roots, with the ligneous covering in which they are inclosed. It must be placed vertically, that it may not incline as it grows, which, without this precaution, would infallibly be the case; and it would thereby lose that majestic appearance which it has when it grows straight.

The pits, which are made in straight lines, are filled up with earth, which is pressed down, as put into the pits, to secure the plant the better, and to retain it in its vertical position: when this labour is finished, the plants are watered after sun-set, and they are covered for about twelve days, to preserve them from the scorching heat of the solar rays: the irrigations are continued as often as possible, according to the dryness of the atmosphere. An adage of the Hindoo agriculturists, respecting the cultivation of this valuable and useful palm, says:—"Water me continually during my youth, and I will quench thy thirst abundantly during the whole course of my life."

Besides this care, which cannot be neglected till its eighth or its tenth year, when this vegetable begins to return with interest the pains and expense bestowed upon it, there is another no less necessary, which must be observed during its whole existence: it is, to cause it to be examined now and then by the *chana* or cultivator. I shall here describe this practice, so necessary to this palm, the only one of the family which requires similar attention.

It is well known that most of the palms have a very delicate part, formed by the leaves not yet developed; this pith or heart, to make use of the expression of the Hindoos, which the Europeans call the *cabbage of the palm*, and which is exceedingly savoury and sweet, particularly that of the coco-nut, and that even of the date tree, and agreeable to eat, attracts a large beetle, armed with two strong terebræ:

terebræ: this insect endeavours to penetrate into the cabbage, where it finds abundant nourishment, of which it appears to be fond.

To get at the heart, which nature has carefully covered, as it seems to contain the vital principle of the tree, this winged beetle is obliged to pierce one of the petioles of the palms, that it may open a passage to the food of which it is in search: but it cannot perform this operation without leaving traces behind it, which are readily perceived by bare inspection of the tree. The *chana*, as soon as he sees a hole newly opened, first probes it with an iron dart, barbed at the point, in order to kill the mischievous insect, and to extract it from its retreat, where it might do injury even after its death.

In other respects nature takes charge of the cultivation till the moment when the tree produces its first spath, or the flower-bud; which is the case at most in its fifth year, if it has been constantly watered; or towards the end of the seventh or eighth, when it has been left merely to the rain.

The land occupied by this useful vegetable not only yields a more beneficial produce than if it were applied to any other kind of agriculture, but the most barren soil is improved by it; shaded by the immense palms of this tree, they are forced to produce good grass, and in the course of a few years to become fit for cultivation.

Though the coco-nut tree has produced oval spaths or buds, which are generally about from twenty-four to twenty-eight inches in length, and about two or three inches in thickness, in the middle; of an elliptical form, a little bent and pointed, inclosing a panicle charged with a great number of small flowers, some of which are succeeded by fruit of a greater or less size, according to the species; the Hindoos do not immediately endeavour to procure from it that liquor called *calou*, from a Tamulic word, which we have adopted.

It is only at the end of the fifth or sixth month, when the tree is vigorous; or the tenth or twelfth, when it is weak, that this liquor is extracted from it. This practice is dictated by prudence, that the tree may not be enervated; as by a different management it would soon be exhausted. Strong palms send forth in general nine, ten, and even twelve buds in the year; those on which little care has been bestowed, and which therefore are feeble, produce only four, or at most five. This fact confirms all the ob-

 servations

servations I have made, and proves the justness of the adage before mentioned.

Many travellers and celebrated naturalists have given descriptions of the coco-nut tree, and its products; and have spoken of its vinous liquor with more or less exactness and truth; but none of them, at least as far as I know, has described either the method in which the latter is extracted, or the preparatory processes followed by the *chanas* of the peninsula of Hindostan, the only part of India, except the island of Ceylon, where this practice is in use. I shall therefore describe these processes, as well as the instruments necessary for succeeding, such as I had an opportunity of seeing them on the coasts of Malabar and Coromandel; and particularly in a plantation of six or seven hundred coco-nut trees, within the walls of Pondicherry, and which was adjacent to my habitation in that place.

At the period judged proper for making the liquor distil from the spaths of the coco-nut tree, the *chana*, to disengage it completely, thins or prunes with a large knife the bases of the petioles of the lateral palms, in order that they may be more easily managed: detaching then a piece of the bark, torn off along its whole length, from the under side of one of the palms, to the breadth of about eight or ten lines, he affixes to it the whole of the spath, beginning by its pedicles. He strongly compresses, and ties fast by means of knots, each annular mark, distant about two finger breadths from each other, to prevent the bud from blowing, either by its efforts in growing, or when it is cut each time after the *calou* has been collected; a labour indispensably necessary, and which I shall explain in the course of this paper.

Having thus bound fast the spath along its whole length, it must be *macerated* with a bat made of hard wood, of a conical form, giving it slight blows along its whole length, and around the bud. Without this bruising, which disposes the liquor to flow, and which I call *maceration*, translating the word literally from that used by the Hindoos, the spath, as is fully proved, would not produce *calou*.

This operation, which takes up five or six minutes, must be repeated regularly every morning and evening for five or six days, and must be resumed twice or thrice during the time that the bud produces liquor. A spath subjected to this process gives *calou* for twenty or thirty days: coco-

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nuts cannot be formed in it: all the flowers being compressed by the ligature must necessarily produce abortion.

Between the third and fifth day, according to the season and the vigour of the plant, the bud is truncated at its extremity by an amputation of about the length of two or three inches; this operation is performed with a knife shaped like a crescent, and well sharpened, that the end which is cut may be smooth; it is carefully repeated morning and evening after the *calou* has been collected. The *calou* does not begin to issue from the bud till the second and sometimes the fourth day after the amputation of the spath; but when it begins to flow with a certain force, it is received in a vessel which is generally of earthen ware. The liquor issues drop by drop from this kind of teat, if I may use the expression in speaking of vegetables. The bud prepared in this manner gives nearly a quart of *calou* in twenty-four hours. This quantity is always proportional to the force of the tree, and the care taken to water it: the case is the same with the number of buds in each tree, which, without exhausting it, can be applied to this purpose. Three or four spaths of a vigorous palm may be made to produce liquor at the same time; but a weak tree by this method would be destroyed. Frequent irrigation, and salt sprinkled three or four times in the year around the roots, are the certain means of strengthening this vegetable, and of causing it to produce abundantly.

But whatever care may be taken in the culture of the plantations, *calou* must not be extracted from all the buds produced by a coco-nut tree in the course of a year; for, however robust it might be, it would soon be exhausted. On this account, one bud in three, at least, must be left for fructification.

This palm, like all those trees of the same species, having a very smooth and lofty stem, leaves no hold to enable a person to climb up it, in order to reach the crown where the buds are situated, and to prepare them by the processes above described for yielding *calou*. It was therefore necessary that this obstacle should be surmounted; and that a method of getting to the top, without danger to the *chanas*, should be discovered; I shall therefore give a brief account of that adopted for this purpose, which is exceedingly simple, but those who practise it must have been habituated to it from infancy.

Furnished with a large leather thong, having at one of its extremities a strong knot, and which is open at the other end, the *chana* puts it round his body, and around the trunk of the

the tree; his feet are confined, and his heels kept together by a strong elastic ring, made of rushes; he then places his feet against the coco-nut tree, and supporting himself by the thong, which is fastened around his body below the arm-pits, and rests on the trunk of the tree at about the height of his head, he prepares to climb, elevating his feet, and supporting himself by the left hand, applied to the tree. The thong is directed by the right hand, and he raises it as soon as his feet have mounted and taken fast hold; he then repeats this operation, till he has reached the summit: when he arrives there, he lets the thong, which must be very elastic, glide over his back, and fall down to his reins. The elasticity of the thong enables him to manage it easily with one hand, either in climbing up or in descending: when thus placed at the top of the tree, and seated on the thong, balancing himself by means of his body and feet, his arms are at perfect liberty, so that he can perform his labour, and collect the *calou* at his ease.

When the palms are very large, the chanas employ a small, light ladder, made of bamboo, by help of which they raise themselves to the height of six or eight feet. By these means they lessen the labour of the method before described, which is attended with great fatigue, however strong, active, or expert, the person may be; especially when it is considered that it is performed twice a day, and that a chana is obliged to cultivate eighty, and sometimes a greater number of palms in the course of a year.

The other implements of this class of labourers are a small coffer and a basket. The former is made of the spaths of the coco-nut tree, and serves for holding the knife; the conical instrument with which the chana beats and bruises the buds, and a box containing the dust of a kind of mica, which he employs for sharpening his knife. The basket, formed of the leaves of the *loutarus* ingeniously interwoven, is so perfectly close that it retains the *calou* which is collected in it, without suffering it to filter through. The small coffer is fastened around the body of the *chana*, and rests on the left thigh; and, when suspended, he holds the panier in such a manner, that neither of them can confine his movements, or impede his operations. Thus accoutred, he climbs up the palm with such velocity, that the eye can scarcely follow him; thirty or forty seconds are sufficient for him to arrange himself, and to reach the summit of the highest coco-nut tree.

Such are the implements and processes employed to obtain the liquor of the coco-nut, a vinous substance, useful in

in the arts, in medicine, and for several domestic purposes. Naturalists have enumerated some of its properties; but, as they wrote only from the reports of others, they have omitted a great number. I shall therefore endeavour to supply this deficiency. In general, every species of this family produces this liquor; but that of the coco-nut tree, and particularly the *loutarus*, furnishes the greatest number of articles, either for the arts or for domestic purposes.

The calou of the coco-nut tree is more saccharine and more nutritious; though used to excess, it can do no hurt to the animal œconomy; and instead of being injurious to the health of man, as all fermented and intoxicating liquors are, it is salutary; or, if it intoxicates, it is only for a moment, and unattended with any danger.

The *calou*, drunk before sun-rise, has so sweet a savour and taste, that it seems to be the nectar spoken of by Homer; but it must be received in a new earthen vessel, for without this precaution it acquires a disagreeable odour, either by negligence, or by the slightest fermentation.

When it is only six or seven hours old, it is employed, without the addition of water, as yeast, in the baking of bread. The bread rises sooner, and is much better; it has a taste, lightness, and whiteness, which no other kind of leaven could give it in the same degree of perfection. It is remarked that sea biscuit baked in India keeps longer, and is superior in quality to that baked in Europe. These facts are well known; every European who has travelled in that country can attest them.

If calou be mixed with a small quantity of beer, a little sugar or syrup, and if an equal volume of water be added to these three ingredients, the whole will form an agreeable and cooling beverage, which may be used at meals.

This liquor is a specific against the scurvy. The Hindoo physicians employ it for nephritic colics, which they radically cure, by making use of it for twenty or thirty days: this remedy, which is composed with four ounces of coriander, dissolved in about a quart of new *calou*, and of which a glassful is given to the patient before meals, three or four times a day, is not nauseous either by its taste or its smell; the coriander dissolves entirely in this menstruum, and colours it: though it has a disposition to speedy fermentation, it does not become sour.

It is well known that an excellent spirit, less injurious in consequence of its balsamic quality than other kinds of spirit, is extracted from this liquor. The calou contains such a large quantity of alcohol, that it gives by distillation more

more than a fourth of its volume of spirit. But what no author has ever yet mentioned is, that to free it from the nauseous and empyreumatic taste which all spirits extracted from substances essentially saccharine, such as this and the juice of the sugar cane, commonly have, the Hindoos add to it, before distillation, water in which they have macerated the flowers of the *moué*, that is to say, a large shrub of the Indies, of which botanists, according to every appearance, have as yet no idea.

These flowers exhale an aromatic odour of cinnamon mixed with that of anise. The *moué*, a shrub unknown in Europe, has a pretty appearance, and rises to the height of twelve or thirteen feet; its stem is cylindric, hard, branchy, and full of cottony pith; its bark is delicate, and of a reddish colour, interspersed with black spots; the leaves are petiolous, a little rough, placed opposite to each other, of a dark green colour, shaped almost like a heart, nervous, and red on the edge and the nerves; the flowers, which are of a beautiful red colour, having each a calyx, velvety on the outside, monophyllous, and with five indentations, are disposed in umbelliferous bunches. A corolla has five divisions, five stamina, an ovarium, conical, bearing a style almost of the length of the stamina, terminated by two setaceous and divergent stigmata: these flowers are succeeded by the fruit or berries, of the form of large coffee-beans, a little turbinated at their lower part, of a yellow red colour, interspersed with red points, pulpy, and containing one or two kernels, pointed, enveloped in a very thin cod, hard, and of a flesh colour; this kernel has the smell of that of the apricot, but is of a bitterer taste.

This spirit is distilled in various parts of Hindostan, in the Decan, and the province of Canara, on the coasts of Malabar and Coromandel, and in the island of Ceylon, where it is called *Columba Arrac.*

I cannot help here rectifying an error in the French translation of G. Forster's Travels from Bengal to Petersbur h, by the way of Cachemir. It is said, in a note added by the translator in the first volume, that the spirituous liquor of India is made from the liquor of the coconut. I must here observe, that several kinds of spirit, each of which has a particular denomination, are distilled in that country. The liquor of the coco-nut, though very sweet, contains no saccharine or alcoholic particles; it never undergoes vinous or acetous fermentation, but only the putrid, which cannot furnish ardent spirit. I hope the translator of that work, for whom I entertain the great-

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est esteem, on account of his character and talents, will forgive me for this criticism. As a friend of truth I have traversed all the provinces of that immense and industrious country, in which I made a number of observations on its arts, sciences, and productions: I learned seven of its dialects, that I might be better able to make myself acquainted with the manners, the religion, and civilization of the inhabitants; and I have been employed for more than twenty-five years on a work which will give an exact account of every thing in it that can excite curiosity, or present to the philosopher subject for meditation.

All the authors who have written on this vegetable have said, that when the calou is concentrated by ebullition, after the vessels in which it is received when it issues from the bud have been covered in the inside with a little lime, it crystallizes by desiccation in the sun into coarse sugar; but none of them have mentioned the use made of it in the arts: this deficiency I shall here supply. Lime, which dissolves all vegetable substances, and liquefies their juice, consolidates the one in question to such a degree, that it is much inspissated before it is boiled; by the process of clarification, it is freed from the small quantity of lime, after which this sugar is employed for different domestic purposes; I have even converted it into coarse sugar candy. It is of great advantage in the art of masonry: works constructed with cement or mortar, moistened with water, in about a hundred quarts of which from fifteen to twenty pounds of this sugar have been diluted, acquire such solidity and tenacity, after complete desiccation, that the bricks or stones cannot be disunited even by the greatest efforts. I mention this fact on the authority of experience; the best and strongest tools in performing this labour are broken. To prove my assertion, I shall mention the experiments I made in the year 1769, when the fortifications of Pondicherry were repaired. The chief engineer being desirous through œconomy to employ part of the old walls, gave orders that they should be cut into blocks, to serve as a foundation for the new ones: this labour occasioned more expense than if new materials had been purchased, in consequence of the loss of time, and the number of tools that were broken during the operation: as a last proof of this assertion, I shall mention that I have seen the halves of large arches remaining suspended, though the other half had been destroyed by the effects of mines employed at the time when Pondicherry was destroyed, in the year 1761. Immense fragments of these arches are still to be seen in the house

of the Jesuits, or in the ruins of the superb government-house built by the order of Dupleix.

The coco-nut tree is one of the most beautiful with which we are acquainted, and, under whatever point of view considered, has an agreeable aspect: its great height; its stem, naturally straight and slender, when it has met with no accident to render it crooked; its bushy summit, crowned with palms of a rich green colour, so pleasant to the eye, ornamented with strong stalks, loaded with enormous fruit, all form an interesting coup d'œil. It presents to the traveller a delicious shade, and the assurance of relieving his most urgent wants, at the same time that its foliage, the pliable alæ of which, long and delicate, sport in the gentle zephyrs, recreates his imagination with a thousand agreeable ideas, and makes him bless and admire the Eternal Power which on his account created so many wonders. Its properties also useful to the arts, to domestic wants, and the comforts of man, amply indemnify the cultivator for his care, and the proprietor for his expense. One cannot refrain from a certain enthusiasm in speaking of this interesting vegetable, one of the most valuable gifts of Providence, and which affords delight even to animals*.

[To be continued.]

LVII. *An Account of Borneo; contained in a Letter from Mr.* John Jesse, *to the Court of Directors, from Borneo Proper* †.

As I am the first servant the Company ever had, or even European, which for a number of years has visited this part

* All animals seek for the shade of this palm. A very pretty sparrow of Hindostan, known by its attachment, and by its address in going to find at the bottom of a well filled with water, and to bring back any thing that has been thrown into it, constructs the nest which is to receive and shelter its young, at the extremity of the alæ of the foliage of this tree. This nest, interwoven with such art and dexterity, that man may admire but cannot succeed in imitating it, notwithstanding the perfection of his organs, is placed by wonderful foresight at the very extremity of these alæ. Agitated by the least breeze, like a cradle, the winds are not able to detach it, nor to throw out the young. This sparrow, by surprising instinct, suspends its nest in this manner, to secure it, in all probability, from the attack of serpents, which cannot reach it in consequence of the pliability of the supporters on which it is placed. But what is more astonishing is the care which this bird takes to light its nest in the night-time, by fixing glow-worms to the inside of it, by means of a tenacious kind of clay.

† From the *Asiatic Annual Register* for 1802.

part of the island of Borneo, I have presumed to lay before you every even the minutest particular which has occurred to my knowledge worthy your observation, that you may be the better enabled to form a just idea of your connexions here, and to judge with precision what measures may hereafter most readily effect the objects you have had in view, by an establishment in this quarter.

The chief and council of Balambangan, in the beginning of the last year, addressed a letter to the state of Borneo, informing them of being arrived at Balambangan, and expressing their wishes to enter into alliance with them. In consequence of this invitation, an ambassador arrived from thence in June; and I had the honour of being appointed to return with him to open an intercourse there, and to enter into such engagements as might appear most to the company's advantage.

I arrived here in the month of August, and found them unanimous in their inclination to cultivate the friendship and alliance of the honourable company: in consequence thereof, I made it my first care to discover the motives which principally induced them thereto, that I might be the better enabled so to frame my treaty as to keep them dependent in such particulars as they most essentially stood in need of; which I then found to be, and have since been confirmed therein, was protection from their piratical neighbours the Sooloos and Mindanaos, and others, who were making continual depredations on their coast by taking advantage of their natural timidity. To relieve them, therefore, in this particular, and to induce them the more readily to consent to my subsequent proposals, I stipulated by one of the articles, that (if attacked) the company should protect them; and having thus gratified them in their principal want, in return I demanded for the company, agreeable to the tenor of my instructions, the exclusive trade of the pepper, as I well knew it was the grand object they wished to attain; and I therefore also made it my study to be thoroughly acquainted with every particular relative thereto. I was informed the quantity that year was 4000 peculs, cultivated solely by a colony of Chinese settled here, and sold to the junks at the rate of 17:2 per pecul, in China cloth called congongs, which, for want of any other specie, are become the standard for regulating the price of all other commercial commodities at this port. Although I was well convinced it could never answer the company's purpose to pay so high a price for the pepper, especially where the quantity was so small, I notwithstanding in the treaty made [illegible] a point

a point of securing to them the exclusive trade of that article, to be paid for in merchandize at such rates as might indemnify them at present in the inconvenience of the high price, to the end that it might divert the channel of the junk trade from this to Balambangan, (their grand inducement for coming here being thus removed,) which, together with my having bound the state to oblige all their dependents to make plantations, whereby the quantity would not only be greatly increased, but, from their having no other purchasers, the company would be enabled to fix such prices as would give ample encouragement to the planters, and soon reimburse the expenses which were necessitated to be borne at the beginning of the undertaking; and the more so, as in consequence of their industry, becoming yearly richer, they would find our protection but the more indispensably necessary.

Things being fixed on this basis, the Englishman and the Bornevan becoming thus mutually necessary to each other, I flattered myself the event might have produced a solid and real commercial advantage as well to the nation as to the company; and the more so, as from the great probability of the hill people being soon induced also to plant, who, by receiving cloth as the price of their industry, would naturally increase the consumption, and render our manufactures with them a necessary of life; these being by far the most numerous, and the aborigines of the island: another advantage accruing therefrom is, that having once connected these people in interest with the company, and familiarized them to our customs, the inhabitants of the sea coast would be unable, were they inclined, to obstruct or molest the prosecution of the company's views. These were the motives which first induced me to secure to the company, in the treaty with the Borneyans, the exclusive trade to the pepper, although at that time on seemingly disadvantageous terms: how far I may have acted with propriety, remains with the company to determine.

I now come to say something of the characteristics of the different sects of the inhabitants.

The Borneyans who inhabit the sea coast are Mahommedans, and, as they say, are originally an emigration from Jehore, but are ignorant of the chronology: they extended their dominions over these coasts, Palawan, Manila, and other parts of the Philipinas; and even Sooloo, as Mr. Dalrymple observes, was formerly a part of this empire. From these extensive conquests, and the unconnected traditions I have had from them, I am inclined to think they were originally

originally a warlike people; but, as most other empires when arrived at a pitch of grandeur have generally declined to nearly their original state, from a want of that vigorous and active government which is so essentially necessary in supporting all acquisitions obtained merely by force of arms, so appears to be the case with that of Borneo; and I am the more convinced of it from that entire indolence and inactivity I found them immersed in on my arrival, being totally degenerated from that courage and enterprise which seems to have marked the character of their roving ancestors, and deprived of their influence in all their former dominions situated to the northward of Borneo.

From what I have been led to say relative to this state, it may be seen they are enervated and unwarlike; added to which they seem to be envious of the private property of each other to a great degree: but, on the other hand, I have found them fair in their dealings; cool and deliberate in their resentments, even where the object is in their power; candid in their intentions; strangers to what we call the world, although not deficient in the innate faculty of the understanding, as they seem to have in great perfection such mechanical arts as are met with in these countries, particularly in the foundery of brass cannon, wherein they excel all the Asiatics I have seen on this side, or have heard of on the other.

That they are constant in their attachments, I think I may say, from their behaviour subsequent to the unhappy capture of Balambangan; for, although threatened by the Sooloos in case they should supply us, and that at a time when many of their boats were trading in the verge of the Sooloo districts, they set them at defiance, and generously afforded such assistance as lay in their power.

With respect to the Idaan, or Mooroots, as they are called here, I cannot give any account of their disposition; but, from what I have heard from the Borneyans, they are abandoned idolators: one of their tenets, so strangely inhuman, I cannot pass unnoticed, which is, that their future interest depends upon the number of their fellow-creatures they may have killed in any engagement or common disputes, and count their degrees of happiness hereafter to depend on the number of human skulls in their possession; from which, and the wild disorderly life they lead, unrestrained by any bond of civil society, we ought not to be surprised if they are of a cruel and vindictive disposition. They are as yet near to a state of nature, but have a great share of innate cunning; of which I had a striking instance in the following circumstance;

circumstance :—Two of their principal chiefs, induced from curiosity, came one day to the factory; they plainly told me they came to see a white man, and should judge of my treatment of them then, what inducement they might have to cultivate an intercourse with me: pleased with the prospect, however faint, of having thus met with an instrument through which I might encompass, in time, what I have ever esteemed my capital object, I endeavoured to ingratiate myself by giving them small presents of different assortments of goods, and expressed a desire to see them again: one only of them shortly afterwards returned with some provisions, which I learnt he had first been endeavouring to sell to the junks, and even then demanded of me such an exorbitant price as I could not think of complying with.

They are represented, however, as industrious in cultivating their paddy plantations, and in following such other employments as are known amongst them; but having no purchaser for their commodity but the Borneyans, who treat them very indifferently, the intercourse, of consequence, is not carried to any extent.

Their arms are long knives and soompittans, a tube of wood, about six feet long, through which they blow small arrows, poisoned at one end, having at the other a small bit of cork wood just big enough to fill up the hollow of the tube, the least touch of which, where blood is produced, is certain death, unless immediately counteracted by the medicine they make use of.

Their dress at present is nothing more than a girdle, or long slip of stuff, made of the bark of a certain tree, which turns between the thighs to cover their nudities, one end of which hangs down before, the other behind.

The civil government of Borneo is vested with a sultaun and a superior council, which consist of those pangarans who hold the great offices of the state; such as a bandahara, in whose hands is lodged the whole executive power; the gadong, or director of the sultaun's household; the tomangong, or commander in chief on their occasional war; the pa mancha, or mediator in disputes; and the shabandar: to assist these are three oran kayos, de gadong, ivattan, and shabandar. There are many others who hold the title of pangarans, but who are called to council only on particular matters.

I cannot better convey an idea of this form of government than to say it bears a strong resemblance to our antient feudal system; for although there is more respect paid to the regal power here than in any other Malay country I

 have

have been in, (for this obvious reason, that the sultaun has entirely the power of appointing the great officers of state, and of course can always influence the public councils,) yet, however, each pangaran has the entire sway over his particular dependents, whose cause they never fail to espouse even where he may stand in opposition to the sovereign authority.

They have no particular laws against treason; murder is capitally punished, except in the case where the master kills the slave; polygamy prevails, as in all other Mahommedan countries, but they seldom intermarry with foreigners: the original law in cases of adultery required the parties to be instantly strangled; but for want of it being properly enforced, and the difficulty there would be found in punishing such as have a number of adherents, people in power often pass with impunity, whilst towards the middle or inferior rank of people it is extended with the utmost rigour. Theft, according to the degree of the crime, is punished with death, or the loss of the right hand. I found in the course of my transactions with them, they have as yet no institutions of a commercial nature; which may be attributed to the want of communication with other nations, the Chinese excepted, who make presents to the head men in lieu of duties. Those of that nation settled here, reap, without molestation, the fruits of their industry; but the casual traders suffer many losses from there being no law which obliges the debtor to discharge his debt, and the necessity they are under of complying with every unreasonable request of those of any consideration in the place.

Having thus communicated what I know of the characteristics and policy of the Borneyans, it will not be improper to observe, that from the plenty and goodness of the timbers found here, the Chinese have been induced to adopt the scheme of building junks, and have found it by experience turn out to advantage, although necessitated to bring the workmen and many of the materials from China. One of the burthen of 7000 peculs (580 tons) was built this year on the following plan: two nouquedahs of junks, and the captain of the Chinese residing here, entered into a contract, whereby the latter, on the one part, agreed to provide the timber, and the former stipulated to bring the artificers and iron-work from Amoy. The keel was laid in the beginning of March, and she was launched the 28th of May: the entire cost and outfit amounting, as I have been informed by the contracting parties, to no more than 8,500

 Spanish

Spanish dollars; which, when allowing for the profits on their congongs, is not more than 4,250 Spanish dollars.

From hence it may be inferred, that should it ever be the company's intentions to establish in these parts a marine wherein small craft might be wanted, they could be built on easy and advantageous terms; as I have found, on inquiry of the nouquedahs, there would be no difficulty in procuring artificers from China, by the junks, on very moderate encouragement.

The river of Borneo is navigable far above the town for ships of a very considerable burthen; and the only difficulty lies at the mouth of it, where the channel is very narrow for about a quarter of a mile in length, through which there is not above seventeen feet at high water: however, the bottom is soft mud, and the place so completely land-locked there never can be any surf, and consequently a ship taking the ground can be attended with no bad consequences.

My non-acquaintance with marine matters disenables me from judging with precision as to the expediency of making docks here; but from the temporary ones made by the Chinese, wherein they build their junks, and out of which they are floated, I should imagine they might be made with conveniency for vessels of 400 tons; and I am rather encouraged in this opinion from the banks of the river being a tough clay, and therefore a good foundation, in which it has the preference above Laboan, the shores there being only a quicksand. The water here flows from eight to nine feet spring tides.

Chimerical are the expectations of finding in these countries any people so disinterestd as not to be ready to take an advantage which chance may throw in their way, where resolutions are not more biassed by dread than attachment; and how unreasonable it is to expect any success in these parts, unless where there is a force sufficient to awe as well as to protect! for although the chief and council here seem to think the Borneyans have infringed their agreement by not giving us the whole of the pepper, yet neither have we, on our parts, been able to fulfil that of affording them protection, which they have experienced by the loss of their boats, seized by our mutual enemy the Sooloos, to the amount of 20,000 Spanish dollars. This will occasion surprise, as there were not only several vessels on the Balambangan establishment, but likewise two small cruizers, sent from Bombay, properly adapted to that purpose: of these, one was upset, being ordered out in tempestuous weather to

cruize

cruize for the ship Louisa, then expected; the other sent with the same vessel to keep a-head of her all the way to China, and which lost her passage in returning, being obliged to bear away for Malacca, from whence she is this month arrived. The public service, therefore, expected to accrue from them has been rendered totally abortive by being made subservient to private convenience; and the protection due to the company's allies having been thus withdrawn, the Borneyans cannot, with justice, be accused of want of faith in not scrupulously fulfilling the engagements on their part.

LVIII. *On the Population of Bengal. By a Gentleman now residing in that Country* *.

In India no bills of mortality, nor registers of births, marriages, and burials, afford data for calculation. The arguments by which we are convinced of the great population of Bengal, arise on the results of various speculations.

The inhabitants of Bengal are certainly numerous in proportion to the tillage and manufactures which employ their labour. Former computations carried the population to eleven millions; and to these a late publication seems to allude in mentioning the number of twenty millions for the inhabitants of our territorial possessions in India; the populations of our dominions in the Deccan being estimated at nine millions.

An inquiry, instituted in 1789, requiring from the collectors of districts their opinions on the populations of their respective jurisdictions, founded an estimate of twenty-two millions † for Bengal and Bahar. Sir William Jones has hinted a higher estimate; and though he has not mentioned the grounds of his opinion, it may be admitted that he has not hazarded a vague and unfounded estimate. We think with him that twenty-four millions ‡ is at least the present number of the native inhabitants of Bengal and Bahar, and shall subjoin arguments which might lead us to compute the population at thirty millions. We cannot, therefore, hesitate to state twenty-seven millions for the whole population, including the zemindary of Benares.

* From the *Asiatic Annual Register* for 1802.

† Quoted from memory.

‡ Preface to the translation of the *Al Sirájiyyah.*

1st. An actual ascertainment * found 80,914 ryots holding leases, and 22,324 artificers paying ground rent in 2,784 villages † upon 2,531 square miles. Allowing five to a family, it gives more than 203 to a square mile; and for the whole of the Dewanny provinces, at that proportion, gives a population of 30,291,051, or, including Benares, 32,987,500: for the area of Bengal and Bahar is 149,217 square miles, and with Benares not less than 162,500.

The district in which this ascertainment was made is not among the most populous of Bengal, but is more populous than the greatest number. In some parts of Bengal considerable tracts are almost wholly waste; if a fourth of the area were excluded on this ground, the proportion of population on a square mile, resulting from an ascertainment in the district alluded to, might be taken for three-fourths of Bengal.

But it must be remembered that many and numerous classes do not pay rent, or contribute directly to the revenues. Some professions are exempted from ground rent; some classes are excused for poverty, others from respect. The tenants of alienated lands are not included in the ascertainment above mentioned: yet the free lands are equal to an eighth of the whole area of the district alluded to; and they do not bear a less proportion to the lands of all Bengal. No city or considerable town was included in the ascertainment; which, for that further reason, may be acknowledged moderate. Upon the whole, we may adhere to the average first suggested, of 200 to a square mile.

2d. General measurements are occasionally undertaken for entire pergunnahs, and for larger districts. In the registers of such surveys the land in tillage, the land appropriated to special purposes, the waste and barren lands, and the ground covered by lakes, are distinguished. Many such surveys ‡ have been examined, and the following proportion

* The result of an official inquiry in the province of Purnea.

† Mauzas. In the same mauza several villages or hamlets may stand; and, on the contrary, the same village will sometimes include several mauzas. The common size of mauzas may be judged from the following ascertainment.

In districts of Bengal, 21,996 mauzas, 18,028 square miles.

Estimates have been attempted from the number of inhabitants found in a few villages, as an argument applicable to the whole number of mauzas. The inquiries have been too limited to afford strong grounds of argument. But the results which have come to our knowledge give 179 inhabitants to each village, 92 males and 87 females.

‡ For specimens of these surveys take the following abstracts from several

portion is grounded on them, making an allowance for great rivers.

Rivers and lakes (an eighth) - - - -	3
Deemed irreclaimable and barren (a sixth)	4
Scite of towns and villages, ways, ponds, &c. (a twenty-fourth) - - -	1
Free lands (an eighth) - - - -	3
Liable for Revenue.	
In tillage (three-eighths) - - -	9
Waste (a sixth) - - - - -	4
	24

If a fourth of the area of Bengal be excluded, as before, for tracts nearly or wholly waste; three-eighths of the remainder give 45,703 square miles; or, omitting Benares, 41,967 square miles, equal to 81,238,112 begahs of land in tillage and liable for revenue; and if half the free lands be cultivated, the whole tillage is 94,777,797 begahs, or 31,331,499 acres.

In some districts, an inquiry undertaken in 1790 ascertained the quantity of land tenanted by near 70,000 cultivators; and it gave an average of less than eighteen begahs each in actual tillage: for, the cultivators paying rent for no more than their actual cultivation, the ascertainment comprehends no lays or fallows.

At this proportion the whole tillage of 94,777,797 begahs must be used by 5,265,432 tenants; and, adding for artificers and manufacturers, &c. at the proportion suggested by the ascertainment of 80,914 husbandmen, and 22,324

veral pergunnahs in circars, Shereefabad, Madarum, &c. measured in 1786, and in circar Tajepoor, measured in 1788:

Waste but reclaimable, as well as forest and steril lands -	449,986
Ponds - - - - -	41,805
Free lands - - - - -	298,275
Productive, including scite of buildings, - -	524,909
Begahs of 80 cubits square -	13,14,975

Pergunnahs in circar Tajepoor, measured in 1788:

Waste but reclaimable - - -	161,225
Barren - - - - -	123,747
Ponds and roads, &c. - - -	24,122
Free lands - - - -	143 042
Cultivated - - - -	301,131
Total begahs -	753,267

These measurements are exclusive of rivers.

 artificers

artificers in the districts alluded to in another place, we have 6,718,154 persons paying land rent and ground rent. If each of these be deemed the head of a family, the population, at five to a family, might be estimated at 33,590,770.

But several rents are not unfrequently paid by the same family; for this reason, the number of husbandmen may be thought over-rated, as in the rent-rolls which were abstracted, tenants holding from more than one landholder, or paying two rents to the same proprietor, must unavoidably have stood for two persons. The excess in the estimate arising from this cause is perhaps not fully balanced by the various classes not contributing directly to the rental.

3d. The same objection occurs to an estimate from the average rents of tenants; it may nevertheless be proper to view the result of a calculation on this ground.

On the rent-rolls examined for the quantity of land as mentioned above, the payments appeared at 478,020 sicca rupees on 68,647 leases to cultivating tenants; or nearly seven rupees each.

In the first year of the permanent settlement the revenue realized to government was current rupees 3,06,98,255, or sicca rupees 2,64,64,094. The assessment was calculated to leave an income to the proprietor equal to a tenth.

Land revenue - -	2,64,64,094
Proprietor's income -	26,46,409
	2,91,10,503

Charges of collections and management, as actually allowed in some instances, and deemed a very moderate allowance, 20 per centum on the gross produce,	72,77,626
Gross rents, or actual payments by tenants	3,63,88,129
Add for free lands in the same proportion as before, 1 to 6 - - - - - - -	60,64,688
Payments by tenants, sicca rupees -	4,24,52,817

At the rate, already suggested, of seven rupees each, these payments arise from 6,064,688 tenants; and assuming their families at five, the population would be 30,323,440.

As ground rents are of small amount in proportion to the land rents, the average of seven rupees for each tenant might have been reduced on this account. This, with the omission of numerous classes not paying a direct rent, may be deemed equivalent for the repetition of names in rent-rolls: and the near coincidence of 30,323,440 with the number of

30,291,051,

30,291,051, resulting from other grounds, supports the computation.

4th. Remains to compare the estimated population with the consumption.

The diet of an Indian is very simple: the diet of one is the diet of millions; split pulse, and salt relieving the insipidity of plain rice. Two ounces of salt, two pounds of split pulse, and eight pounds of rice, is the usual daily consumption of a family of five persons in easy circumstances; whence we have the average consumption of salt in a year at 9lb. a head.

The annual sales of salt, an article monopolized by government, are 35,31,944 maunds of 80 sicca weight; but the whole quantity is not consumed in Bengal. A proportion not inconsiderable is exported.

On the other hand, the lower classes in the western provinces seldom taste sea salt: these, and the mountaineers from Rajemahl to Palamow, use rock salt imported from western countries, a bitter salt extracted from ashes, or impure salt obtained from the mother of nitre. The latter is much used by the venders of salt in adulterating sea salt; and, generally speaking, no sea salt is allowed to cattle.

If the substitutes for sea salt be equivalent to the exportation of that salt, it will require a population of 32,228,989 persons to consume 35,31,944 maunds of salt.

5th. From what has been stated as the daily consumption of a family, an average of nine maunds a head arises for the annual consumption of grain. The use of wheat and barley in some provinces will not affect the calculation, but millet and other small grains, which constitute the principal food of the poor, and which are not equally nourishing with white corn, will increase the average.

Several sorts of pulse are grown for cattle, but bear a small proportion to the general tillage; for the cattle are mostly supported on pastures and on straw.

Corn is imported from several of the countries which border on Bengal; but the exportation from Bengal exceeds the import; we therefore estimate the produce, from the consumption of the supposed population, at 270 millions of maunds; and at 300 millions after adding grain for cattle; to this add a seventh for seed reserved, and the whole produce in grain will be 34,28,57,140 maunds,—a very moderate produce for the tillage estimated at 9,47,77,797 begahs.

But the Indian husbandry mixing in the same field with corn other articles of a very different nature, to compare

 the

the produce to the quantity of land, every article must be included in the computation, and for that purpose the grain must be stated at its money value, which we take from the average of many inquiries, in which the cheapest and dearest provinces have been considered.

Maunds.	Rupees.
15,00,00,000 of rice, wheat, and barley, at 12 annas - - - -	11,25,00,000
6,00,00,000 millet, &c. at 8 annas -	3,00,00,000
9,00,00,000 pulse, at 10 annas -	5,62,50,000
	19,87,50,000
4,30,00,000 seed reserved - -	2,83,80,000
	22,71,30,000
Oil seeds - - - -	12,000,000
Sugar, tobacco, cotton, &c. - -	70,000,000
Sundries - - - -	20,000,000
Gross produce of land -	329,130,000

which is more than seven* rents, if the rents have been well estimated at rupees 42,452,817, and a produce of three rupees and a half a begah on the tillage, estimated at 94,777,797. In a subsequent inquiry we shall have occasion to show this a very moderate produce in proportion to the expense of husbandry.

The speculations in which we have now indulged cannot avail to determine accurately the population of these pro-

* The gross payments of the husbandmen are greater; probably not less than the fourth of the gross produce: which was considered under the latter administration of the native government as the just due. Another occasion will occur of examining this subject more fully, and explaining the appropriations of the gross collections. The difference, though it break the consistency of the argument, is in favour of the moderation of our estimate. It is explained by the circumstance of the ascertainment before quoted, having been made in a district where the net revenue bears a very large proportion to the gross collections, and where the husbandmen are estimated on the rental to pay a seventh only. The net revenue bears a less proportion to the gross revenue in most districts; and in these the peasants pay more than a fourth. This does not affect the computation; for had we used materials obtained from districts where the gross payments were greater in proportion to the net revenue, or had we included all the payments not brought on the rental, the average payment of each tenant would be found proportionably higher. In some the husbandmen pay more than a fourth of their gross produce; in others they nominally pay more than half. On the other hand, in frontier districts, particularly on the estates held upon Ghativali tenure, they pay less than a seventh.

vinces,

vinces, but make it probable that it has been under-rated. It is undoubtedly adequate to undertake greater tillage, and more numerous and extensive manufactures, than now employ the labour of our Asiatic subjects; but, wanting a vent for their produce, they have no inducement for greater industry. If more produce were obtained, its market being barred, industry would be unrewarded. The necessaries of life are cheap, the mode of living simple; and though the price of labour be low, a subsistence may be earned without the uninterrupted application of industry. Often idle, the peasant and manufacturer may nevertheless subsist. A few individuals might indeed acquire wealth by diligent application; but the nation at large, doomed to poverty by commercial limitations, can apply no more labour than the demand of the market is permitted to encourage. If industry be roused, the present population is sufficient to bring into tillage the whole of the waste lands in Bengal and Bahar; and in most districts improvement may be expected whenever new channels of trade are opened to take off more or new produce. In all it may soon follow the event, if Europeans interest themselves in undertakings for the reclaiming of waste tracts.

Of this we are convinced, aware, however, that the culture must require a considerable proportion of labour, for in the common husbandry the field yields several crops within the year. But requiring no manure except for some articles, and for these manured without labour or expense, the same quantity of land should need fewer hands in Bengal than in England, since the labours of the husbandman suffer less interruption from the inclemency of seasons.

The improvements to be expected from a better and more diligent husbandry may be appreciated after reviewing the present system of agriculture.

That the revenue mostly follows a proportion to the area of the districts, may be shown by a comparison to the revenue of 1784, which distant period is taken because districts having been new modelled, their area under late distributions is not ascertained.

Districts.	Square miles according to Rennel.	Revenue of 1794.
Beerbhoom - - -	3,858	6,11,321
Bishenpore - - -	1,256	3,86,707
Chittagong, Islaamabad, and Tipperah Lowlands, Tip-		

perah

Districts.	Reserved as nearly Waste.	Square miles according to Rennel.	Revenue of 1794.
perah woods, the last nearly waste - -	5,250	4,317	6,79,197
Dacca - - -		15,897	31,62,386
Dinagepore - -		3,519	14,60,444
Kishenagur (Nuddea) -		3,115	10,27,427
Midnapore - -		6,102	8,89,941
Purneah - - -		5,119	10,00,479
Rajemahl and Boglepore; (Curruckpore and Curruckdee,) nearly waste -	5,453	5,034	5,47,600
Rajeshahy - - -		12,909	24,00,000
Silhet - - -		2,861	2,33,824
Sarun and Bettya -		5,106	13,12,721
Tirhoot and Hajypore -		7,815	7,01,234
Baha Proper, Rotas, and Shahabad - - -		12,129	24,59,807
Burdwan - - -		5,174	43,58,026
Pachete, Chuta, Nagpoor, Palamow, and Ramghur	16,732	5,000	1,61,216
Sunderbunds, Cooch-Behar, and Rangamatty; nearly waste - - -	10,114		
Districts the distribution of whose area is not ascertained, including the productive districts of 24 pergunnahs, Hoogly, town of Calcutta, and Murshedabad - -		12,921	61,66,670
Total -	37,549	149,217	2,75,59,000

The cultivated tracts in the districts reserved as nearly waste, are fully compensated by the waste tracts in districts stated as well cultivated; hence the argument, on which a fourth of the area has been excluded as waste. The average of revenue on the whole area is current rupees 184 per square mile; on three-fourths of the area well cultivated, it is 246 per square mile. The revenue of most districts compared to their area falls between those limits. No ascertainments have been admitted in the preceding computation, but those obtained within the districts marked, where the revenue is nearly 200 current rupees per square mile; which circum-

stance

stance shows them to be in a middle class between the depopulated and waste, and the populous and highly cultivated districts.

In the present distribution of districts, the dearest and most productive are Burdwan, 24 pergunnahs, Nuddea, and town of Calcutta; the cheapest and least productive are Ramghur, Silhet, Cooch-Behar, and Tipperah. We use no information from these districts in computing the prime cost of productions and price of labour.

LIX. *Twentieth Communication from Dr.* Thornton, *relative to Pneumatic Medicine.*

To Mr. Tilloch.

Jan. 17, 1805.
No. 1, Hinde Street, Manchester Square.

DEAR SIR,

I AM happy when I can employ my pen for the promotion of the most valuable of the sciences, discoveries relative to the removal of disease, and the restoration of health. That the newly discovered gases deserve the attention of the philosophic world at large, and that of the practitioner of medicine in particular, the several facts I have recorded seem indeed to warrant, and I shall in the progress of your magazine be able to add considerably to the quantity of evidence already adduced.

Case of a bad leg cured by vital air.

John Richards, æt. 12, son of a carpenter in North Row, Park Street, Nov. 7, 1803, was in company with some boys, near a stable, when a lad threw down upon them a truss of straw from a loft, which pitched upon master Richards, and he fell to the ground, and considerably bruised the left leg. This confined him to the house for a fortnight. The leg soon became discoloured, and was much swelled, and discharged a corrosive humour. Various applications were employed, which only assuaged a little the pain, but the disease went on increasing, and the lameness continued; it looked angry along with the blackness, and showed erysipelatous inflammation*, the forerunner frequently of gangrene or mortification. Under these alarming circumstances, about the latter end of February, he was placed under Mr. Moor, son of the late

* Mr. Moor explained this to the mother of the child, by calling it St. Anthony's fire.

celebrated

celebrated Dr. Moor, a surgeon whose intrinsic merits need no commendation from my pen, and the lad was under his care about a fortnight; when, with that caprice so often seen in the middle stations of life, he was brought to me by his mother in March. I wrote to Mr. Moor a letter to apologize for taking from him a patient, especially in surgery; but as I was to receive no pecuniary advantage, I felt in this the less reluctant: and after six weeks trial of the oxygenating plan, I had the pleasure of seeing the lad restored to the full use of his limb, in health, and spirits.

Observations on this case.

1. The blackness seemed to indicate a defective oxygenation of the part:—it had existed from November to March.

2. The outward applications employed were common ointments, and occasionally a very weak solution of lunar caustic (oxygenated silver).

3. Silver, we know, in its pure state is the most inoffensive of metals: but when oxidated imparts the readiest to the animal fibre its superabundant oxygen.

4. The blood was at the same time superoxidated by the inhalation of vital air, which oxygen imbibed by the blood it would impart to the limb, as it passed along in the route of the circulation: or at any rate there would be determined more arterial blood to the diseased part, by the increased stimulus to the heart.

5. Why, I ask, are bad legs so frequent, and not bad arms, unless from the greater distance of the lower extremities from the seat of circulation, the fountain of arterial blood?

6. But laying all reasoning aside, under this process, the system being likewise invigorated by bark, as the actions of life were increased, the patient lost his lameness, and the limb took on a far more healthy appearance.

7. His appetite was greatly increased.

8. He became more lively.

9. The blackness gradually diminished; and,

10. After six weeks the left leg had all the freedom of the other, and looked healthy.

11. Jan. 17, 1805. The lad is before me, who is sound of limb, in health, and spirits.

I have the honour to be, sir,

Your obliged faithful servant,

ROBERT JOHN THORNTON.

LX. *On*

LX. *On Fumigation.* *By* Dr. Thornton.

The calamities occurring in life, even the most prosperous, are always great, and mankind, as if callous to these, add those of war to the afflictions that are unavoidable. Instead of trading with each other, we see civilized, I cannot call such *christian** nations, weltering themselves in human blood, and this man, contrary to the command of his Creator, lifting up his arm to slay "a brother," against whom, in fact, he has no ill will,—thus to make mourn a wretched widow and disconsolate family. To famine, usually comes in league with war dire pestilence, and we in this nation have every reason to dread the arrival of this impending calamity, which has already desolated America, is now ravaging Spain, has carried off half our garrison at Gibraltar, and is very likely, from our unavoidable intercourse with Spanish prisoners, to enter this country. For the healthy to avoid infection, and yet maintain *intercourse* with the sick in *putrid fever*, has been long practised by me, as physician to a large public charity, by *fumigation*, and is taught in the following part of my Philosophy of Medicine, vol. iv. p. 385. fourth edition, published in 1799.

"The commission at Moscow, of which Prince Orlow was at the head, having, in the year 1770, invented a *fumigation-powder*, which, from several lesser experiments, had proved efficacious in preventing the infection of the plague; in order more fully to ascertain its virtue in that respect, it was determined, towards the end of the year, that *ten* malefactors under sentence of death should, without undergoing any other precautions than daily fumigations, be confined three weeks in a lazaretto, be laid upon the beds, and dressed in the clothes, which had been used by persons sick, dying, and even dead, of the plague in that hospital. The experiment was accordingly tried; and *none of the ten malefactors were then infected, or have been since ill.* The fumigation-powder is prepared as follows:

"*Powder of the first strength.*—Take leaves of juniper, juniper-berries pounded, ears of wheat, guaiacum-wood pounded, of each six pounds; common *saltpetre* pounded, eight pounds; *sulphur* pounded, six pounds; Smyrna tar, or myrrh, two pounds: mix all the above ingredients together; which will produce a pood of the powder of fumiga-

* Christianity teaches us "to love one another."

tion of the first strength. [*N. B.* A pood is 40 pounds Russian, which are equal to 35 pounds and a half or 36 pounds English avoirdupoise.]

"*Powder of the second strength.*—Take southern-wood cut into small pieces, four pounds; juniper-berries pounded, three pounds; common *saltpetre* pounded, four pounds; *sulphur* pounded, two pounds and a half; Symrna tar, or myrrh, one pound and a half: mix the above together; which will produce half a pood of the powder of fumigation of the second strength.

"*Odoriferous powder.*—Take the root called *kalmus*, cut into small pieces, three pounds; leaves of juniper, cut into small pieces, four pounds; frankincense pounded grossly, one pound; storax pounded, and rose flowers, half a pound; yellow amber pounded, one pound; common *saltpetre* pounded, one pound and a half; *sulphur*, a quarter of a pound: mix all the above together; which will produce nine pounds and three quarters of the odoriferous powder.

"In all these, the *acid fumes* from the *nitre* and *sulphur* form the principal part. The rest appears only useful in holding these in a state of longer suspension."

LXI. *Analytical Experiments and Observations on Lac.* *By* Charles Hatchett, *Esq. F.R.S.**

The period is uncertain when the substance called Lac, so curious in its origin and so useful to many arts, was first introduced into Europe; and although it probably was known to the antients, yet the inaccuracy of their descriptions precludes this from being stated as a positive fact.

The natives of India have long employed it for various purposes, exclusive of those which cause it to be in request with Europeans; but many of the Indian processes are undoubtedly as yet unknown to us.

One of these, of a very useful nature, was some time since obligingly communicated to me by Charles Wilkins, Esq. F.R.S., and has been the cause of this inquiry into the nature and properties of lac.

Mr. Wilkins informed me, that the Hindûs dissolve shell-lac in water, by the mere addition of a little borax; and the solution, being then mixed with ivory-black, or lamp-black, is employed by them as an ink, which, when dry,

* From Philosophical Transactions for 1804.

dry, is not easily acted upon by damp or water. Upon trial, I found the fact to be exactly as Mr. Wilkins had stated, and therefore made other experiments; but the results of these I shall at present omit, as they will occur with more propriety and perspicuity in the latter part of this paper.

In respect to the natural history of lac, we are much indebted to Mr. Kerr *, Mr. Saunders †, and Dr. Roxburgh ‡; from whose valuable communications to this Society, we learn many curious particulars concerning the formation of this substance, which, from their accounts, and from inspection, evidently appears to be the nidus or comb of the insect called coccus or chermes lacca, deposited on branches of certain species of mimosa and other plants.

Lac is distinguished into four kinds; of which, however, only three are commonly known in commerce, *viz.* stick lac, seed lac, and shell lac; the difference of these, with that of the fourth, called lump lac, is as follows.

1. Stick lac, is the substance or comb in its natural state, incrusting small branches or twigs.

2. Seed lac, is said to be only the above, which has been separated from the twigs, and reduced into small fragments; but I suspect it to have undergone some other process, as I have found the best specimens to be very considerably deprived of the colouring matter §.

3. Lump lac, is formed from seed lac, liquefied by fire, and formed into cakes. And,

4. Shell lac, according to Mr. Kerr and Mr. Saunders, is prepared from the cells, liquefied, strained, and formed into thin transparent laminæ, in the following manner.

"Separate the shells from the branches; break them into small pieces; throw them into a tub of water, for one day; wash off the red water; dry the cells, and with them fill a cylindrical tube of cotton cloth, two feet long, and one or two inches in diameter; tie both ends, and turn the bag above a charcoal fire; as the lac lique-

* Natural history of the insect which produces the Gum Lacca. By Mr. James Kerr, of Patna. Phil. Trans. for 1781, p. 374.

† Some account of the vegetable and mineral productions of Boutan and Thibet. By Mr. Robert Saunders. Phil. Trans. for 1789, p. 107.

‡ Chermes Lacca. By William Roxburgh, M. D. Phil. Trans. for 1791, p. 228.

§ Mr. Wilkins informs me that the crude lac, as it is taken from the branches and twigs of the trees, is usually deprived of its colouring matter by boiling, having been previously reduced, by pounding, into small fragments. In Bengal, the silk-dyers are the people who thus produce what we call the seed lac, which they do for the sake of the colour.

fies, twist the bag, and when a sufficient quantity has transuded the pores of the cloth, lay it upon a smooth junk of the plantain tree, and with a strip of the plantain leaf draw it into a thin lamella; take it off while flexible, for in a minute it will be hard and brittle*."

The degree of pressure on the plaintain tree, regulates (according to Mr. Saunders) the thickness of the shell; and the quality of the bag determines its fineness and transparency.

Assam furnishes the greatest quantity of the whole of the lac now in use†.

Mr. Kerr (speaking of stick lac) observes, that the best lac is of a deep red colour; for, if it is pale and pierced at the top, the value is diminished, because the insects have left their cells, and consequently these can be of no use as a dye or colour, but probably may be better for varnishes.

The seed lac which I have examined, contained but little of the colouring matter, and appeared (as I have already observed) to have undergone some process of purification; but, of all the varieties, shell lac contains the least of the tinging substance, as may well be expected, when the mode of preparing it is considered.

It is remarkable, that although lac has been known and imported into Europe, during so long a time that the date cannot now be ascertained, yet it has but little attracted the attention of chemists.

The first chemist of eminence who mentions it, and the only one who has subjected it to any thing like a regular examination, is the younger Geoffroy, whose paper is published in the *Mém. de l'Acad. de Paris* for the year 1714‡. In this paper, Mr. Geoffroy seems to have been chiefly induced to examine it on account of its tinging substance; but he nevertheless has not neglected the substance which constitutes the cells. This he considers to be a sort of wax, very distinct from the nature of gum or resin. But it is to be observed, that he formed this opinion, not so much upon the results of chemical experiments, as upon the cellular construction observed in the stick lac, which, as he justly remarks, demonstrates it to be formed by insects, after the manner that the honeycomb is formed by bees; and that it is not therefore, as some have supposed, a

* Phil. Trans. 1781, p. 378. † Phil. Trans. 1789, p. 109.

‡ Observations sur la Gomme Lacque, et sur les autres Matières animales qui fournissent la Teinture de Pourpre. Par M. Geoffroy le jeune. *Mém. de l'Acad.* 1714, p. 121.

gum

gum or resin, which has exuded from vegetables simply punctured by insects*.

Geoffroy and Lemery obtained from lac, by distillation, some acid liquor, and a butyraceous substance. Moreover, Geoffroy observes, that when stick lac was thus treated, some ammonia was also obtained, but not when seed lac was employed.

He also mentions another sort of lac, brought from Madagascar, and called by the natives *Lit-in-bitsic*. This substance, he says, is scarcely to be distinguished from bees-wax, which it much resembles in colour and odour; and that it is produced by a grayish insect, much larger than the chermes lacca. It is evident however, from Geoffroy's description, that this substance is very different from the common lac; and there can be little doubt, but that it is the same as that which was a few years ago examined by Dr. Pearson under the name of white lac, a substance resembling the Pé-la of the Chinese†.

Geoffroy (as I have stated) considered lac as a sort of wax; and since his time it has scarcely, if at all, been subjected to chemical examination; it is not therefore surprising, that the opinions of chemists concerning it have been various. Chaptal adopts the opinion of Geoffroy, and calls it a kind of wax‡; but Gren§ and Fourcroy‖ regard it as a true resin.

§ I.

Effects of different menstrua on the varieties of lac.

1. When water is poured on stick lac, which has been separated from the vegetable branches, and reduced to a coarse powder, it immediately begins to be tinged with red; and, with the assistance of heat, a deep coloured crimson solution is formed.

Repeated operations of this kind reduce stick lac to a yellowish-brown substance; and the water no longer receives any colour.

The portion thus separated from stick lac has, upon an average, amounted in my experiments to about 10 *per cent.*

* Mr. Kerr observes, that as a red substance is obtained by incision from the plaso tree, very analogous to lac, it is probable, that the insects have little trouble in animalizing the sap of these trees, in the formation of their cells. Phil. Trans. 1781, p. 377.

† Phil. Trans. 1794, p. 383.

‡ Chaptal's Elements; English edition, vol. iii. p. 387.

§ Principles of modern Chemistry, vol. i. p. 388.

‖ *Système des Connoissances chimiques*, tome v. p. 624.

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but this is not to be regarded as the total quantity, for a part is obstinately retained by the resin and other ingredients, so that it cannot be completely separated; and moreover, very considerable variations must be expected in different samples.

Fine seed lac did not afford more than $2\frac{1}{2}$ or 3 *per cent.* of the colouring substance; and shell lac, when treated in the same manner, (*i. e.* merely with water) did not yield more than $\frac{1}{2}$ *per cent.*

2. Alcohol dissolves a considerable portion of each of the different kinds of lac; and, when heat is not employed, the dissolved part is resin, combined with some of the colouring matter; but, if the lac is digested with heated alcohol, then the solution is more or less turbid, in consequence of some of the other ingredients becoming mixed and suspended; so that it is afterwards extremely difficult to obtain it in a state of purity and transparency, either by repose or by filtration.

The resin may be obtained by immediately subjecting the solution to evaporation or distillation, or by previously pouring it into water with which a small quantity of muriatic or acetic acid has been mixed; for thus, when the whole is heated, a curdy precipitate of resin is formed, and may be separated by a filter, after which, the liquor may be evaporated, in order to obtain any resin or other substance, which may remain in solution after the first operation.

The solution formed by digesting stick lac in alcohol, without heat, is of a dark brownish-red colour, and the insoluble part subsides, in the state of a dark coloured magma; this retains the greater part of the colouring matter, which, as I have already observed, is most easily soluble in water.

The proportion of resin thus dissolved, when stick lac is treated with alcohol, has, in my expeeiments, amounted to 67 or 68 *per cent.* but this must depend on the quality of the samples.

The seed lac which I examined was very pure, and yielded to alcohol about 88 *per cent.* of resin: it contained but little of the colouring matter; and the other substances subsided, and formed a cloud at the bottom of the glass vessel.

Shell lac in small fragments, by simple digestion with alcohol, afforded in the first instance nearly 81 *per cent.* Part of the resin, however, still remained mixed with the residuum, and could not be separated but by subsequent operations: this part amounted to about 10; so that the total

quantity

quantity of resin, in the shell lac which I employed, may be estimated at 91 *per cent.*

When the shell lac was only reduced into small fragments, these (after the separation of the first portion of resin) retained their figure, but were become more bulky, very elastic, and nearly white. I at first therefore suspected, that some caoutchouc was present in lac; but finding that boiling water destroyed this elasticity, I was induced to make subsequent experiments, by which I discovered, that the elasticity of this residuum was principally owing to a substance which appeared to possess the properties of vegetable gluten. This, however, I shall more fully notice in another part of the paper.

The resin obtained from the varieties of lac is brownish yellow, and is not so brittle as the generality of other resinous substances.

3. Sulphuric ether does not seem to act so powerfully upon the varieties of lac as alcohol; for, as a great part of the resin is protected by the colouring matter, and by the other ingredients which are insoluble in ether, it naturally follows, that less of it can be separated by this liquid than by alcohol.

The different kinds of lac which have been digested in ether are considerably softened, although in other respects very little alteration is produced. Ether, therefore, is not the best menstruum for lac; but, under certain circumstances, it may be occasionally employed with advantage, for the purpose of analysis.

4. Concentrated sulphuric acid acts in the first instance on the colouring matter of lac; but, after a short digestion in a sand-bath, the whole is converted into a reddish-brown thick liquor, which soon becomes black; and the chief part of the lac is separated, in an insoluble state, resembling coal.

During the solution of lac in sulphuric acid, a considerable quantity of sulphureous acid gas is evolved.

5. When lac is digested with nitric acid, nitrous gas is at first produced; the lac swells much, and is converted into a deep yellow opaque brittle substance, which, by a sufficiency of nitric acid, and continuation of the digestion during about 48 hours, is dissolved.

The solution however is turbid, and, when poured into a large quantity of distilled water, deposits some yellowish flocculi, which being collected, are found to be a sort of wax.

The filtrated liquor is of a bright golden yellow; and, when saturated by ammonia, changes to orange colour; but does not yield any precipitate, nor any traces of oxalic or malic acid.

This yellow nitric solution is converted, by evaporation, into a deep yellow substance, which burns like resin, but is soluble in boiling water.

The alkalis and lime, being added to this aqueous solution, do not produce any precipitate, but the yellow colour is very considerably deepened; and, by evaporation, an orange-coloured substance is obtained, which is still easily soluble in water, and consists of the deep yellow substance abovementioned, combined with the alkali or lime.

6. Muriatic acid dissolves the colouring matter and gluten of lac; but its action on these is feeble, unless the resin has been previously separated.

7. Acetous acid, in its effects, much resembles muriatic acid.

8. Stick lac, seed lac, and shell lac, are partially dissolved by acetic acid; and, if this be heated, a considerable portion is taken up.

The dissolved part consists of the colouring extract, of resin, and of gluten; the wax being the only ingredient which is insoluble in this menstruum; but a portion of the former substances, being enveloped by the wax, is protected from the action of the acetic acid.

The acetic solution of lac becomes turbid when cold, and deposits part of the resin; a portion however remains in solution, and may be precipitated by water; after which, the liquor retains some gluten and colouring extract, which may be precipitated by saturating the acid with an alkali, and by subsequent boiling.

For the reasons above stated, it would be difficult to effect a complete solution of lac by means of acetic acid; but this may nevertheless be advantageously employed in analytical operations, when alternately used with alcohol.

9. A saturated solution of boracic acid in water, dissolves the colouring extract; but, as the effect does not surpass that of water alone, we may conclude that lac is little, if at all, acted upon by boracic acid.

10. It has been already stated, that sub-borate of soda or borax has a powerful effect on lac, so as to render it soluble in water; and, as the preceding experiments prove that boracic acid alone scarcely acts upon lac, there is every reason to believe, that the excess of soda present in borax

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is the active substance; and this conclusion will be confirmed, by the results of subsequent experiments made with the alkalis.

In order to render lac (especially shell lac) soluble in water, about $\frac{1}{5}$ of borax is necessary; and this may be previously dissolved in the water, or may be mixed and added together with the lac.

The best proportion of water to that of lac is 18 or 20 to 1. So that 20 grs. of borax, and four ounces of water, are, upon an average, requisite to dissolve 100 grains of shell lac; but more water may be occasionally added, to supply the loss caused by evaporation during the digestion, which should be made nearly in a boiling heat.

This solution of shell lac is turbid, and of a reddish-brown colour: when considerably diluted with water and agitated, a weak lather is formed; it is decomposed by acids, and the lac is precipitated in yellow flocculi, which do not apparently differ from the lac originally employed.

The general properties of the solution show, that it is a saponaceous compound, which, being used as a varnish or vehicle for colours, becomes (when dry) difficultly soluble in water, although this was the liquid employed to form the solution.

A white thick scum or cream collects on the surface of this liquid, after it has been suffered to remain tranquil for some time, and is found to be produced by a sort of wax, which I shall more particularly notice when the analyses of the varieties of lac are described; but, in the present case, this wax appeared in some degree to be converted into an almost insoluble soap by the alkali of the borax, and may be regarded as the principal cause of the turbidness of the solution.

11. The lixivia of pure soda and of carbonate of soda completely dissolve the different kinds of lac; and these solutions exactly resemble those formed by means of borax, excepting that they are deeper coloured.

Rather less than $\frac{1}{5}$ of carbonate of soda is required to dissolve shell lac; and this solution, when dried, is sooner affected by damp or water than the solution prepared by borax.

12. Lixivium of pure or caustic potash speedily dissolves the varieties of lac, and forms saponaceous solutions, similar to that in which borax was employed, exclusive of the colour, which is deeper, and more approaching to purple.

Lixivium of carbonate of potash extracts a great part of the colouring matter, but does not form so complete a solution of the entire substance of lac, as when pure potash is employed.

The above alkaline solutions, by repose, afford the waxen soap which has been mentioned; and acids, being added to these solutions, and to that formed by borax, precipitate the lac in a flocculent state, and of a yellow or buff colour, which precipitate, when melted, becomes similar to the lac originally employed. If however an alkaline solution of shell lac (prepared, for instance, with soda) be gradually dropped into a sufficient quantity of muriatic acid diluted with an equal portion of water, and nearly heated to the boiling point, and if after boiling the whole for about one hour the coagulum be separated, and the clear liquor be carefully saturated with soda, and again made to boil, a small quantity of a flocculent precipitate is obtained, which was found to be analogous to precipitated vegetable gluten, combined with some of the colouring extract.

13. Pure ammonia and carbonate of ammonia readily act upon the colouring matter of lac, but do not completely dissolve the entire substance.

[To be continued.]

LXII. *Experiments and Observations on Feathers, and the Down of domestic Fowls.* By M. Parmentier.

[Continued from page 217.]

Swans' Down or Feathers.

Among the wild swans, there are some the plumage of which is entirely white, like that of domestic swans: others, and this is the case with the greater number, are rather gray than white; and this gray is of a darker colour on the head and back, so that it appears almost brown.

Domestic swans are stripped of their feathers twice a year, in the same manner as geese. They furnish a down much sought after on account of its softness, and which is employed for stuffing pillows and beds. It is well known also that the same substance, exceedingly fine, and softer than silk, is used for powdering-puffs: it is formed also into beautiful muffs and fur articles, which are both light and warm. The feathers of the wings are preferable to those of the goose for writing, and for the tubes of painting-brushes.

Ducks'

Ducks' Down or Feathers.

Though the down of common fowls and pigeons is not neglected in some districts, the palmipedes furnish the principal part of that consumed in Europe.

Ducks' feathers are sufficiently elastic, and sold at a certain price in the ci-devant Normandy, where great numbers of these birds are reared. They are used for pillows and mattresses.

Goose Down or Feathers.

The common goose, and particularly the large species, which, since time immemorial, have been subjected to a state of domesticity, supplies the greater part of the feathers and down employed in Europe. It was long believed that the health of these birds was injured by depriving them of their feathers; but if the operation be performed before moulting, this periodical disease is not followed by any inconvenience when properly performed, and in such a manner as to take from each wing only the down and four or five feathers.

When the young birds have attained the age of two months, they are conducted different times to a piece of clear water; they are then placed on clean straw, in order that they may become dry; they are speedily stripped of their feathers for the first time, and then a second time at the commencement of autumn; but with moderation, on account of the approaching cold, by which they might be injured.

Another precaution, which ought always to be known, is, that when geese are stripped of their feathers they must be prevented from going to the water, and made only to drink, during two days, till their skin becomes firm. They are then plucked a third time, when they are killed, after they have been fed. This bird, therefore, which has lived about nine months, can furnish, in the course of its life, three crops of feathers.

The advantage to be derived from goose feathers is no where to be neglected: they form an important article of commerce in Lincolnshire, where they are sold, in down or in writing-quills, to a considerable amount every year.

To neglect the advantage of obtaining once, twice, or thrice, in the course of a year, a crop of writing quills, and of down for filling beds and pillows, would be to renounce voluntarily a considerable and certain profit which might be derived from a numerous breed of geese. It is estimated that this product varies with age, and that a mother-goose

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gives in general a pound of feathers; a young one furnishes always half a pound.

Geese destined for peopling farm-yards, and which are what is called old geese, may, indeed, be plucked thrice a year, without inconvenience, at an interval of seven weeks; but young ones before they are subjected to this operation must have attained to the age of thirteen or fourteen weeks, and especially those soon destined for the table, because they would become meagre, and lose their quality.

The nature of the food contributes very much to the value of down, and to the strength of feathers: the particular care taken of geese has no less influence. It has been remarked, that in places where these birds find a great deal of water they are not so much subject to vermin, and furnish feathers of a better quality.

There is a sort of maturity in regard to down, which may be easily discovered, as it then falls of itself: if removed too soon it will not keep, and is liable to be attacked by worms. Lean geese furnish more than those which are fat: it is also more esteemed. Farmers ought never to suffer feathers to be pulled from geese some time after they are dead, for the purpose of being sold; they generally smell badly, and become matted: none but those plucked from living geese, or geese which have been just killed, ought to be introduced into commerce. In the latter case, the geese must be plucked soon, and in such a manner that the operation may be terminated before they are entirely cold: the feathers are then much better.

Desiccation of Feathers.

Whatever be the kind of birds from which feathers are obtained in the greatest abundance, those principally used ought to be plucked from a living animal; and they may be easily known, as the barrels, when pressed between the fingers, emit a bloody liquid. Those plucked after death are dry, light, and liable to be attacked by insects; but feathers and down of the best quality, collected before moulting, and in the proper season, require, as already observed, precautions, in order that they may be preserved in a good state. They are always accompanied by a fat lymphatic matter, which becoming altered would communicate to them an odour exceedingly disagreeable. They must therefore be subjected to previous desiccation, and exposed in an oven after the bread has been taken from it. This desiccation ought even to be carried further when the feathers are those of aquatic birds, in consequence of their oily nature.

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When this previous desiccation has been effected, the feathers are conveyed to a dry airy place, where they are stirred every day. By these means the pith contained in the barrels is dried; the greasy and membranous parts of their surface are dissipated in dust. The quill may then be kept for centuries: but if these precautions be neglected, if the quill is not reduced to the state of pure parenchyme, and if it contains half-dried juices, it will then become a prey to insects. In this case it must be bleached in soap water, and then washed several times; a secondary operation, which determines the elastic quality of the quill, and occasions a loss.

What has been said of feathers is applicable to wool: if badly scoured, the yolk and fat matters with which it is impregnated attract insects; it must then be washed to prevent its total destruction, and be freed from this natural fat matter, which is liable to corrupt.

The matters employed in beds in country houses must be put into a hurdle supported by a trestle in the middle of a well aired apartment; they must then be stirred and beat from time to time with a switch; exposed often to the open air; to the cold during the fine days of winter, and to the sun in the beginning of spring, to remove that kind of insect of the class of the phalenæ which is propagated only in the shade, and in a state of repose. Daylight and agitation are means far preferable to the aromatic plants proposed for producing the same effect.

The process of purification consists in putting into three pints of boiling water a pound and a half of alum and as much cream of tartar, which are diluted in twenty-three pints more of cold water. The wool is then left immersed in this liquor during some days, after which it is washed and dried. After this operation it will no longer be subject to be attacked by insects.

The purity of feathers and wool employed for mattresses and cushions ought to be considered as a first object of salubrity. Animal emanations may, under many circumstances, be prejudicial to the health; but the danger is still greater when the wool is impregnated with sweat and the excrementitious parts of persons who have experienced putrid and contagious diseases. Bed-clothes and the wool of mattresses, therefore, cannot be too often beat, carded, cleaned, and washed. This is a caution which cannot be too often recommended.

LXIII. *On rendering Assistance to Persons in Danger of Drowning.* By H. LAWSON, *Esq.*

To Mr. Tilloch.

SIR,

I AM induced to offer the following remarks by the melancholy circumstance that took place on the 13th instant, in consequence of the ice breaking and letting some of the skaiters into the water of the Serpentine river; but more especially from the distressing circumstances that attended one gentleman, who was ultimately lost, after supporting himself near twenty minutes, in the sight of some hundreds of spectators, many of whom made great, though ineffectual, exertions to save him; in which most probably they would have succeeded if they could have procured some buoyant body to assist them.

The above circumstance called up the utmost energies of my thought to find if there was no part of a man's dress that might be serviceable either to assist the sufferer, or enable a man of ordinary courage to venture to his relief. Indeed, even a swimmer will not hastily go near a drowning person, let him swim ever so well; for, with his clothes on, he is fully occupied in keeping himself above water, and dares not risk being seized in a disadvantageous position by persons devoid of all recollection (arising from their perilous situation), and ready to grasp at every thing that comes within their reach. But if the swimmer could take with him into the water any thing that would support from five to ten pounds weight, he would be able, perhaps, to render assistance without danger to himself. This desirable object seems to me to be attainable by the proper use of a man's hat and pocket handkerchief, which (being all the apparatus necessary) is to be used thus:—Spread the handkerchief on the ground, and place a hat, with the brim downwards, on the middle of the handkerchief; and then tie the handkerchief round the hat as you would tie up a bundle, keeping the knots as near the centre of the crown of the hat as may be. Now by seizing the knots in one hand, and keeping the opening of the hat upwards, a person, without knowing how to swim, may fearlessly plunge into the water with what may be necessary to save the life of a fellow-creature.

The above is the ground-work, and the most ready application of the idea; but, where circumstances and time will permit, various modes may be adopted: as, taking two hats and tying the two ends of a walking-stick into the knots of

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the handkerchiefs, and then seizing the stick by the middle; or, indeed, as many hats may be put on the walking-stick as it will hold, which will not be less than four, giving a buoyancy equal to 28 pounds or more, without the risk of the hats filling with water. If, instead of a stick, two hats were connected together by a handkerchief, the hats may be used to swim with as boys use corks.

As this is the time of year in which most accidents happen of the description which I am trying to avert, I hasten to give it to the public, that it may get as extensive and quick a dissemination as possible; though perhaps, with more thought, the plan may be capable of improvement.

One circumstance more I shall beg leave to mention, before I make some general observations. If a person should fall out of a boat, or the boat upset by going foul of a cable, &c., or he should fall off the quays, or indeed fall into any water from which he could not extricate himself, but must wait some little time for assistance, had he presence of mind enough to whip off his hat and hold it by the brim, placing his fingers within side the crown, and hold it so, (top downwards,) he would be able by this method to keep his mouth well above water till assistance should reach him. It often happens that danger is descried long before we are involved in the peril, and time enough to prepare some one of the afore-mentioned methods; and a courageous person, I am confident, would, seven instances out of ten, apply to them with success; and travellers in fording rivers at unknown fords, or where shallows are deceitful, might make use of the first of these methods with advantage.

By experiments I have made, it appears that a common sized hat, such as is now in fashion, will support more than ten pounds weight without sinking; but with a weight of about seven pounds it would not be liable to fill, even if there were a little ripple on the water. The handkerchief, applied as above directed, covering the open part of the hat, prevents its being readily filled by the splashing of the water; and as it is well known that the human body is nearly of the same specific gravity as water, it must be evident that a buoyancy of seven pounds will, if properly managed, keep the head sufficiently above the surface till more effectual assistance is procured.

Chancery-lane,
January 25.

I am, sir, your obedient servant,
HENRY LAWSON.

P. S. Would it not be useful, if, at the different receiving-houses of the Humane Society, a number of large foot-balls,

balls, with a short line and small weight, were kept for emergencies, as they might be thrown to a great distance; and if one should be caught by the sufferer, it would be fully sufficient to support him till more effectual assistance could be obtained.

Quere—Have the Humane Society at their receiving-houses any marine spencers? which appear to be better adapted for the purpose we have been speaking of, than cork jackets.

LXIV. *Letter from Mr.* William Reid, *Merchant, in Peterhead, in Scotland, respecting a Mode of curing malignant and epidemical Fevers.*

SIR,

By advice of Mr. James Arbuthnot, in consequence of your answer to my former letter, I shall detail the first discovery I made of this new remedy.

About twenty-seven years ago, a fever, called epidemical, was brought into the family by one of my brothers, of which he died. I found I had contracted the fever—so much, that the veins and arteries of my thighs and legs moved with violent motion, as do the strings of a harpsichord; which made me very sick, and almost caused me to faint. In farm-houses in the country they have a custom of melting tallow with red-hot tongs to make candles. At the time above mentioned they were going on with the process; and the house being small, the smoke reached my bed. I found the smell of the burning tallow so grateful to my senses, that it entirely put a stop to the convulsed state of my veins, and took away the sickness. When the process ceased, I found the complaint returned, though not so violent. I then rose from my bed, and repeated the process several times until I found no returns for that night and next day, and the next day I was able to go some distance for necessaries for the sick. It would be too tedious to repeat all the trials I made; suffice it to say, I never had a settled fever in my life. I find that something of this kind was used in early ages. If these observations should meet with your approbation, other particulars shall be sent.

I am, with the greatest respect,
Your most obedient humble servant,
William Reid.

LXV. *Notices respecting new Books.*

Sir John Sinclair, who has long laboured for the benefit of the community, has just issued a prospectus of a new work, to be entitled *The Code of Health and Longevity*. We subjoin a copy of his Sketch of the Plan.

The medical authors who have hitherto written on health, have commonly restricted their observations to six general heads: 1. Air; 2. Diet; 3. Motion and Rest; 4. Sleeping and Watching; 5. Retention and Excretion; and, 6. The Passions of the Mind. To these they have given the singular name of the six *non-naturals*, from the idea that though, if they were managed with prudence, they might be entitled to the name of naturals, yet as they are much oftener abused, and thence are the source of various disorders, they are more frequently acting against, than with nature, and therefore may be properly termed *non-naturals* *. Some authors on health have also gone into the discussion of what they call *non-necessaries* †, in which they include clothing and the professions of life. But as such a mode of explaining the doctrines of health and longevity is in many respects defective and exceptionable, it is not proposed to adhere to it upon the present occasion.

The most natural division of the subject under consideration seems to be, to point out,

1. The circumstances which necessarily tend to promote health and longevity, independent of individual attention.

2. The rules which, if observed by an individual, have a tendency to preserve health and existence, even where these independent circumstances are wanting. And,

3. The regulations by which the general health and safety of a great community are protected from the various injuries to which they are likely to be exposed.

Part I.

Circumstances which necessarily tend to promote health and longevity.

It will hardly be disputed, that while individuals differ

* Lynch's Guide to Health, p. 61. Mackenzie, in his History of Health, Introd. p. 4. gives a different account of the compound word *non-natural*, which, he says, originated from the jargon of the Peripatetic schools. It was first mentioned by Galen, who divides things relating to the human body into three classes: Things which are *natural* to it; Things which are *non-natural*; and, Things which are *extra-natural* (Class. 7. lib. de Ocul. Partic. tertia, c. 2.) From this fantastical distinction, the epithet non-natural, he says, first arose.

† Strother's Essay on Sickness and Health, p. 445.

so much from each other with regard to a variety of important particulars, as the climate in which they reside, the manner in which they are formed, &c. that there must necessarily be a material difference with respect to the duration of their lives. It is essential therefore, in the first place, to ascertain what these particulars are. It seems to me that they may be all comprehended under the following general heads:

1. Form and growth of the individual.
2. Natural constitution.
3. Disposition of mind.
4. Parentage.
5. Climate.
6. Education.
7. Rank in life.
8. Particular occupation.
9. Connubial connexion. And
10. Sex.

Where a favourable condition of all, or the greater part of these circumstances occurs, there health and longevity may be expected.

In some particular cases also, it may be proper to remark that nature seems to make a fresh effort, and in some measure to renew the distinctions of youth, and some of the circumstances which attend it.

PART II.

Rules for preserving health and promoting longevity.

It is evident, that if men lived uniformly in a healthy climate, were possessed of strong and vigorous frames, were descended from healthy parents, were educated in a hardy and active manner, were possessed of excellent natural dispositions, were placed in respectable situations in life, were engaged only in healthy occupations, were happily connected in marriage, &c. &c. there would be little occasion for medical rules. But it is universally known, that some individuals enjoy only a part of those advantages, whilst others possess hardly any of them complete. Hence arises the necessity of attending to those *rules* which observation and experience have pointed out as being the most likely to counteract the disadvantages arising from so material a want as of any of the natural advantages above enumerated. These rules relate to

1. Air.
2. Diet.
3. Digestion, and its effects.

4. Clothing.

4. Clothing.
5. Habitation.
6. Exercise of the mind.
7. Exercise of the body.
8. Sleep.
9. Amusements.
10. Habits.
11. Temper, or disposition. And
12. Medicine.

To which will be added, several rules of *a miscellaneous nature*, concerning the means of alleviating the effects of the various accidents to which persons are exposed; together with observations on the necessity of adhering to different rules, according to climate, peculiar occupations, &c.

PART III.

Regulations for the health of the community.

It is in vain, however, that either nature has formed an individual for long life, or that he observes all those rules which are necessary for the preservation of health, unless attention be paid by the government of a country, to the happiness and safety of its subjects. This is a point which has seldom been attended to in the manner in which its importance deserves. While the attention of lawgivers is unceasingly directed to a variety of less important objects, those regulations on which the safety of the people at large depends are unfortunately neglected. Yet what can be more pernicious than to suffer the climate of a country, for instance, to continue noxious to the health of its inhabitants, merely for want of drainage, cultivation, and improvement, when thousands of instances might be adduced of the advantages which have resulted from the adoption of an opposite system? What can be more impolitic than to permit unwholesome provisions and other articles to be sold, without punishing those who thus attempt to injure the health, perhaps to destroy the existence, of their fellow-creatures? What more dangerous, than to permit public amusements of a pernicious nature; to authorize improper customs; to neglect the education of youth, when the foundation ought to be laid of their future health and strength; to suffer public institutions to become the seminaries of disease; to disregard the safety of those who are trained for the public defence; to sanction the sale of noxious or doubtful medicines; and, above all, to permit the least risk of contagious disorders being admitted into a country, by which its whole population may be affected?

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The police of public health, therefore, is a most important branch of the proposed inquiry; and the events which have recently happened in Spain and at Gibraltar have given it additional interest. It may be treated of under the following general heads:

1. Police of climate.
2. Police of physical education.
3. Police of diet.
4. Police of public amusements.
5. Police of habits and customs.
6. Police of public institutions.
7. Police for the health of sailors and soldiers. And,
8. Police of medicine, and the means of promoting its improvement.

CONCLUSION.

Such is the plan of the intended work, which others might doubtless have executed with more ability, but none with a more anxious wish that it may prove *substantially serviceable* to the interests of human nature; or, at any rate, useful to those who may apply their talents to render the investigation therein carried on still more complete.

LXVI. *Proceedings of Learned and Economical Societies.*

ROYAL ACADEMY OF BELLES LETTRES, HISTORY, AND ANTIQUITIES, AT STOCKHOLM.

This academy has proposed the following as prize subjects for the year 1805.

I. *History.*—An account of the administration of the finances in Sweden during the middle ages. The prize is a medal of 26 ducats.

II. *Inscriptions and emblems.*—Sketches for an epitaph on king Charles Knutson; sketches of medals on the interesting events which took place in Sweden under the reigns of Gustavus Adolphus or Charles X. The prize is a gold medal of the value of 12 ducats.

III. *Antiquities.*—A complete collection of the Icelandic traditions which relate to the history of the north, with an account of their antiquity and of the authors. The prize is a gold medal value 15 ducats.

IV. *Philology.*—A philosophical comparison between the Greek and Roman tragedy and comedy and those of modern nations. The prize is a medal of the value of 26 ducats.

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BOARD OF AGRICULTURE.

Premiums offered by this Board.

[Concluded from p. 275.]

Hydraulic Machine.

A foreign gentleman offers to give a premium of fifty guineas for the plan of a machine, adjudged to be the best by the Board of Agriculture, for a supply of water. It is proposed to raise water continually from a rivulet, and effect its elevation to a hill.

1. The rivulet is sixteen feet wide and one foot deep, and continually flowing a rapid course.

2. The fall of the rivulet is from a height of twelve feet.

3. The ascent to which the water must be raised, is 280 feet.

4. The distance of the fall of the rivulet, from the spot where the water is intended to be raised, is 1500 feet.

5. The drawings exhibited to gain the premium must be as accurate as possible, with the dimensions set forth, in order that the machinery may be constructed therefrom. Such a drawing of this machine must further have annexed to it a statement of its mechanic powers, expense of construction, and such other explanations necessary for the clear comprehension of the whole.

6. The drawing that gains the premium will be that which will prove that its model will, 1st, supply the most water; 2dly, be of the most simple construction, and not subject to frequent repairs.

To be produced on or before the first Tuesday in February, 1805.

N. B. *The first of the general conditions applies to this premium.*

N. B. In all cases where money is offered, the successful candidate may have the value in plate, with a suitable inscription.

General Conditions.

All candidates are desired to observe that,

1. The board reserves to itself the power of withholding any premium, when the communication or communications, implement or implements, &c. is, or are, not deemed sufficiently important to merit the reward.

2. The MSS. &c. sent in claim of premiums, to remain the property of the board.

3. All memoirs, &c. sent in claim of premiums, to be without the name of the author, or any intimation to whom they

they belong (except where otherwise directed), but with a mark or number, and accompanied by a sealed letter (on which is to be written the same mark or number), containing the name and address of the claimant, and the certificates; which sealed letter will not be opened, unless the premium be adjudged to the MS. &c. bearing that mark or number. Without the attention of the writer to this circumstance, the board cannot vote any reward to such MS. &c.

Persons sending memoirs, or implements, &c. in claim of premiums, are requested to desire some person to inquire the determination of the board, within twelve months after the MS. &c. is delivered.

In case of no application, the letter, containing the name and address of the claimant, will be burned.

LXVII. *Intelligence and Miscellaneous Articles.*

TAVISTOCK CANAL.

Such of our readers as take an interest in important national works, will not be displeased with some account which we have procured of the canal lately begun in the neighbourhood of Tavistock.

Near this town, and between the river Tavy, which flows through it, and the Tamar, which forms almost the whole line of separation between the counties of Devon and Cornwall, is a hill called Morwel Down, rising to the height of about 700 feet above the level of the tide. Being in the centre of a district in which valuable mines both of copper and tin, but principally of the former, have lately been discovered, and having on its surface the symptoms of veins, or, as the Cornish miners call them, lodes; which will probably yield those metals, plans of piercing through this mountain have often been proposed; and lately, owing to the spirited exertions of gentlemen concerned in the neighbouring mines, seconded by the concurrence of his Grace the duke of Bedford, on whose property the whole is situated, the scheme has been entered into, and some considerable progress in its execution already made.

As the river Tavy is not navigable, while the Tamar at the foot of the ground proposed to be cut through is so for large vessels, the idea of opening a canal from each end of the proposed tunnel, to make a water communication between the interior country and the river, easily suggested

 itself.

itself. The undertaking, therefore, embraces two great objects; first, to serve the public by forming an easy conveyance for limestone, coal, ores, slate, and other heavy articles, which are daily passed along its line; and, secondly, to be the means of discovering the treasures at present concealed in the bowels of this mountain.

An act of parliament for the navigation was passed in the summer of 1803, and in the month of August the works were begun. From a report of the committee of management lately made to the general meeting of proprietors, which has been printed, we find that to complete this undertaking, after rising to the proper level from the river Tamar by an inclined plane, a tunnel about a mile and three-quarters long must be driven through the hill, and that the canal must be carried over a valley at the height of more than 40 feet; where the navigation will branch off, the main part going to the town of Tavistock, and passing some copper mines, and the other part reaching to the extensive slate quarries of Mill Hill.

Of the great deal of work to be done for the completion of this undertaking, the tunnel and the aqueduct are the parts attended with the most difficulty. The former, which must be cut through solid rock, can go on only by slow degrees; and the latter will be forwarded nearly in the same proportion, as a great part of it will consist of embankment raised with the rubble brought from the tunnel; the excavation of the one thus serving towards the formation of the other.

The engineer, Mr. John Taylor, has been able already to complete nearly 300 yards of the tunnel; and by an open canal from its northern entrance, he conveys in boats the stuff to the valley where he is raising the embankment: here, by an inclined railroad, and very simple machinery, these boats are made to ascend out of the water over the spot where their load is to be thrown, and, being fixed in a balanced cradle, the whole is inverted, and thus the rubble is instantly discharged into its proper situation.

The tunnel is worked from each of its ends, and likewise from shafts sunk, and which are sinking, upon its course; water from the river Tavy will be turned through the open part of the canal, and will be made to fall over very powerful wheels for draining the shafts, ventilating the levels, &c. &c.

The search for minerals has already been attended with some success. The vein or lode worked in a neighbouring mine has been traced into the limits of the canal, and near

the end of the tunnel it has been discovered to contain rich copper ore. The usual means of following this lode are employed, and we may doubtless expect to hear that from this and the other parts of this curious and interesting undertaking, the proprietors will in time be amply repaid for their spirit and enterprise.

METEORIC STONE.

On the 13th of December 1803, between eleven and twelve in the forenoon, the inhabitants of the village of St. Nicholas, near the small village of Maesing, were alarmed by a noise which resembled the report of several cannons. A peasant went out from his house to see what was the matter; and looking at the clouds, which became dark and gloomy, he heard a singular hissing in the air, and observed something fall on a barn with a loud noise. On entering the barn he found a stone which had broken the rafters of the roof by its fall, and taking it up found that it had the smell of sulphur, and that its heat was more than temperate: it weighed three pounds and a quarter.

There are several instances in Bavaria and Austria of the fall of such stones. On the 20th of November, 1768, one fell at Mauerkirchen that weighed 38 pounds: it was of a triangular form, and only eight inches in thickness; it was accompanied with the same phænomena in the atmosphere, except that it was almost as dark as at midnight, and the stone by its fall made a hole in the earth two feet and a half in depth.

In the environs of Eichstadt a similar stone fell several years ago in the month of January during a severe cold, the ground being then covered with snow.

The first-mentioned stone had a thin blackish crust, which seemed to be bituminous on the fracture: it was of an ash gray colour, earthy, and resembling hardened clay, but without any odour. By analysis it contained native iron, or iron in the metallic state, which appeared, in the form of small shining particles; martial pyrites in small bright grains, which when pounded gave a black powder; different flattened masses of a black and dark brown colour, which were distinguished by their hardness, and were exceedingly bright; some small grains of a cubical form; and small yellowish transparent leaves or laminæ, with *glas glanz*, which had the appearance of quartz, but which was not so hard. With the microscope there were remarked yellowish white metallic points, which resembled the magnet, and which probably were metallic nickel.

4 The

The chemical analysis of 10000 grains gave

Iron in the metallic state -	1800
Brown oxide of iron -	2540
Regulus of nickel - -	1350
Magnesia - - -	3250
Silex - - -	1000
The rest seemed to be sulphur	60

LONGEVITY.

That instances of longevity are not so rare in modern times as is usually imagined, the subjoined list, collected from various sources, is a curious proof, to which I beg you may give a place, if you think it will afford any amusement to your numerous readers. That I might not swell it to an inconvenient length, none have been inserted who have not attained the 130th year, or whose longevity has not appeared to be well attested. Many more might, without doubt, be added, by those who have better opportunities for collecting such accounts. The date affixed to each name is the year in which each person died, when that has been ascertained; or when not, the latest year in which each is known to have lived.

Year.		Age.	Year.		Age.
1795	David Cameron	130	1772	Mrs. Clum	138
1766	John de la Somel	130	1766	Thomas Dobson	139
1766	George King	130	1785	Mary Cameron	139
1767	John Taylor	130	1752	William Laland	140
1774	William Beatie	130	——	Countess Desmond	140
1778	John Watson	130	1770	James Sands	140
1780	Robert Macbride	130	1773	Swarling, a monk	142
1780	William Ellis	130	1773	Charles M'Findlay	143
1764	Elizabeth Taylor	131	1757	John Effingham	144
1775	Peter Garden	131	1782	Evan Williams	145
1761	Eliz. Merchant	133	1766	Thomas Winsloe	146
1772	Mrs. Keith	134	1772	J. C. Drahakenberg	146
1767	Francis Agne	134	1652	William Mead	148
1777	John Brookey	134	1768	Francis Consir	150
1744	Jane Harrison	135	1542	Thomas Newman	152
1759	James Sheile	136	1635	Thomas Parr	152
1768	Catherine Noon	136	1656	James Bowles	152
1771	Margaret Forster	136	——	Henry West	162
1776	John Moriat	136	1648	Thomas Damme	154
1772	—— Richardson	137	1762	A Polish peasant	157
1793	—— Robertson	137	1797	Joseph Surrington	160
1757	Wm. Sharpley	138	1668	Wm. Edwards	168
1768	John M'Donough	138	1670	Henry Jenkins	169
1770	—— Fairbrother	138	1782	Louisa Truxo	175

To these may be added, a Mulatto man who died in 1797, in Frederick Town, North America, and who was said to be 180 years old.

In *The County Chronicle*, of December 13, 1791, a paragraph was inserted, which stated, that Thomas Carn, according to the parish register of St. Leonard, Shoreditch, died the 28th of January, 1588, aged 207; but this is an instance of longevity, so far exceeding any other on record, that one is disposed to suspect some mistake either in the register or in the extract.

WATER-SPOUTS.

We are happy in being able to present our readers, in the present number, with a correct representation of this phænomenon, copied from nature. As it was not accompanied with any circumstances different from what are usual, and have often been stated, a particular description is unnecessary. It seldom happens, however, that they are seen, as in the present instance, by persons competent to make a correct drawing.

METEORO-

CONTENTS

OF THE

TWENTIETH VOLUME.

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XXXV. *An*

METEOROLOGICAL TABLE
By Mr. Carey, of the Strand,
For January 1805.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Dec. 27	34°	35°	34°	29·59	4°	Cloudy
28	34	33	30	·72	6	Cloudy
29	30	32	25	·92	10	Cloudy
30	24	31	30	30·12	15	Fair
31	31	32	30	29·94	12	Fair
Jan. 1	30	32	35	·78	8	Cloudy
2	36	39	36	·88	0	Rain
3	36	38	38	30·02	6	Cloudy
4	37	42	36	29·98	12	Fair
5	39	44	40	·85	10	Cloudy
6	41	45	42	·98	4	Small rain
7	44	47	40	·78	0	Rain
8	32	41	31	30·38	6	Fair
9	34	33	27	·30	3	Foggy
10	25	29	28	·05	5	Foggy
11	32	32	28	29·66	5	Cloudy
12	25	29	37	·40	0	Cloudy
13	39	43	42	28·98	5	Fair, with wind
14	39	43	35	29·16	6	Fair
15	33	42	36	·30	4	Fair
16	34	45	34	·65	2	Cloudy
17	35	46	36	·50	6	Fair
18	34	40	34	·72	8	Fair
19	32	40	37	·20	5	Fair
20	41	45	38	28·96	2	Rain
21	32	37	32	29·18	4	Cloudy, snow at night
22	33	33	32	·09	0	Cloudy, snow at night
23	33	33	33	·28	0	Snow
24	30	32	31	·61	5	Cloudy
25	30	35	32	·63	4	Cloudy
26	29	29	28	·75	8	Cloudy

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Copper.

Phos-

Under-

END OF THE TWENTIETH VOLUME.

Printed by R. Taylor and Co., Black Horse Court, Fleet Street.


TWO HORNED RHINOCEROS.
ONE HORNED RHINOCEROS.
Fig. 1.
Upper jaw
Fig. 2.
Lower jaw
Fig. 3.
Upper jaw
Fig. 4.
Lower jaw
Fig. 5.
J. Lee sculp.

IMPROVED MALT KILN.

Fig. 1.

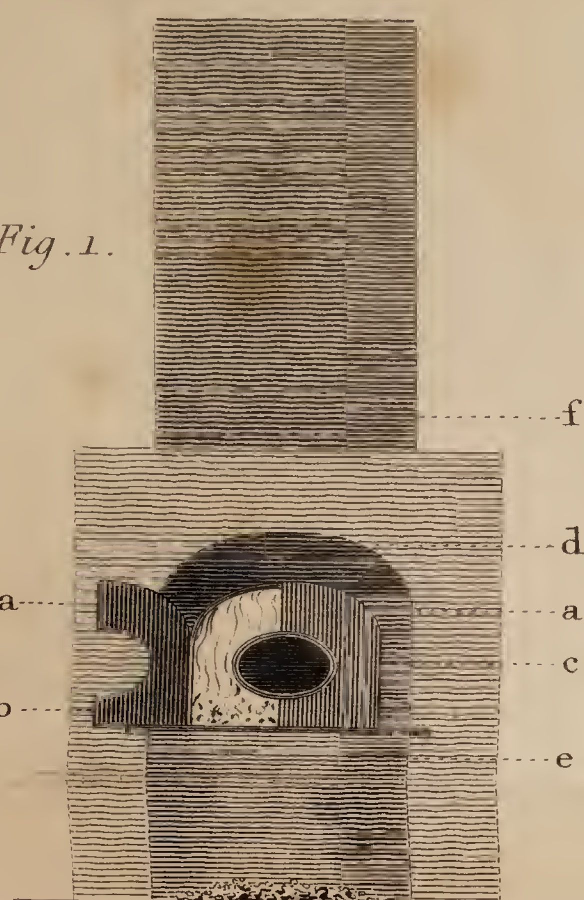
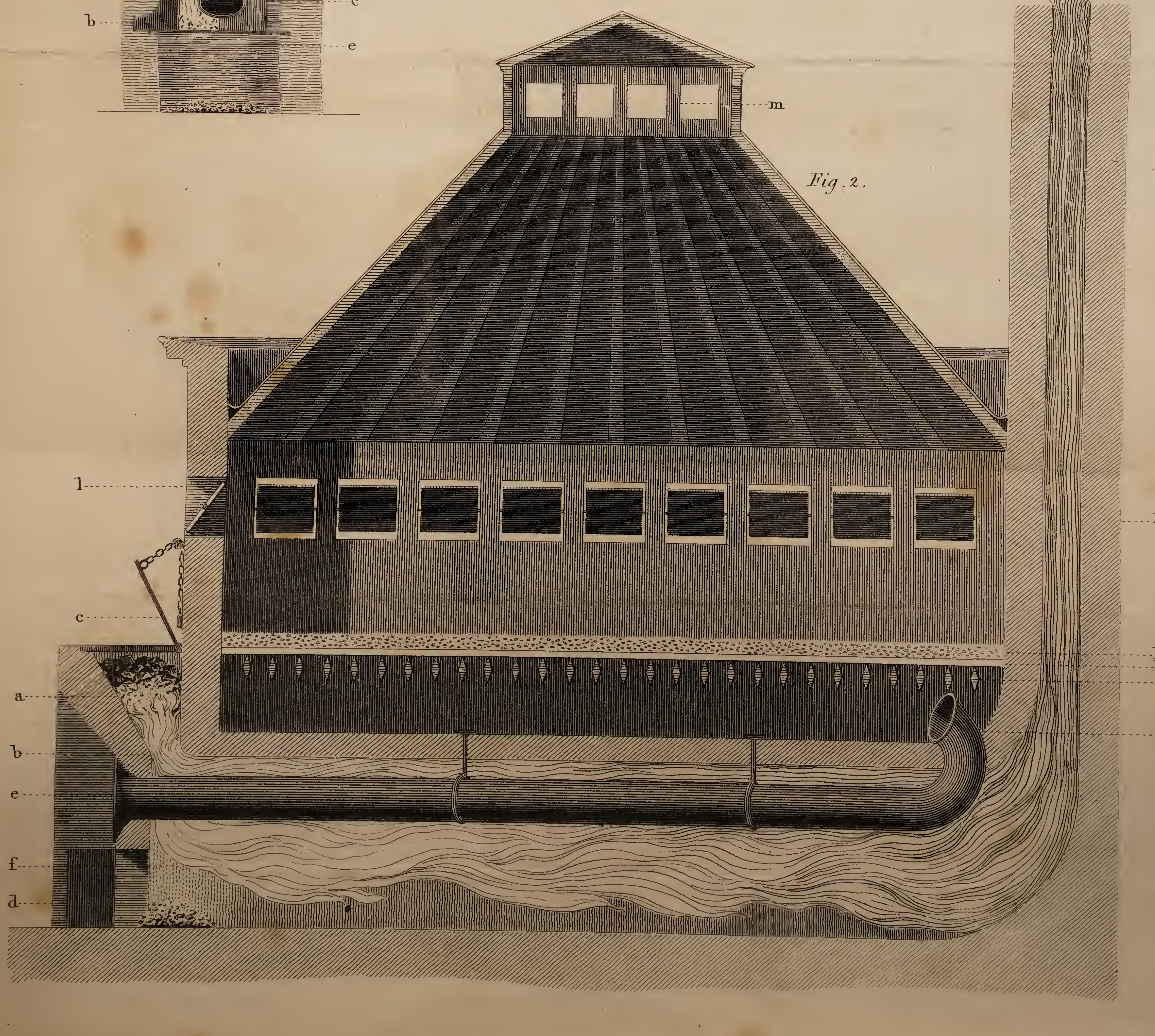
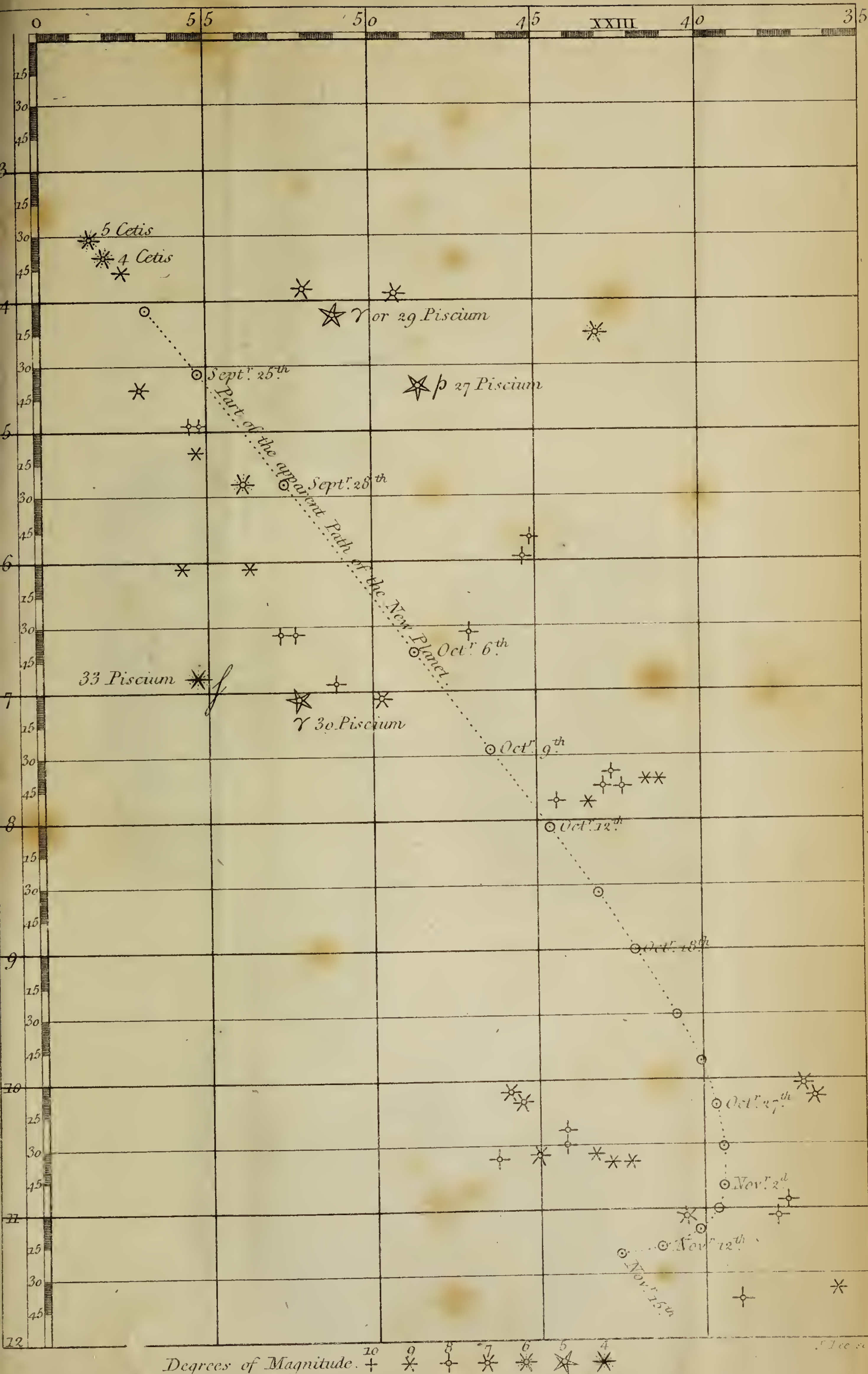


Fig. 2.



Lowry


XXIII
5 Cetis
4 Cetis
γ or 29 Piscium
ρ 27 Piscium
33 Piscium
f
γ 30 Piscium
Sept.r 25th
Sept.r 28th
Part of the apparent Path of the New Planet
Oct.r 6th
Oct.r 9th
Oct.r 12th
Oct.r 18th
Oct.r 27th
Nov.r 2d
Nov.r 12th
Nov.r 15th
Degrees of Magnitude.
10
9
8
7
6
5
4

FOSSIL TEETH OF THE RHINOCEROS.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

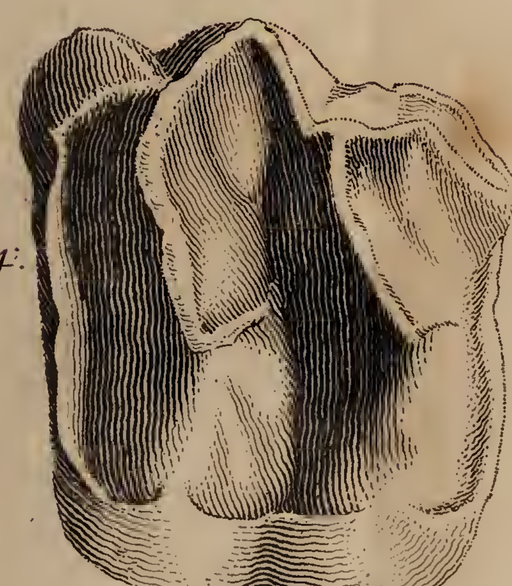


Fig. 5.

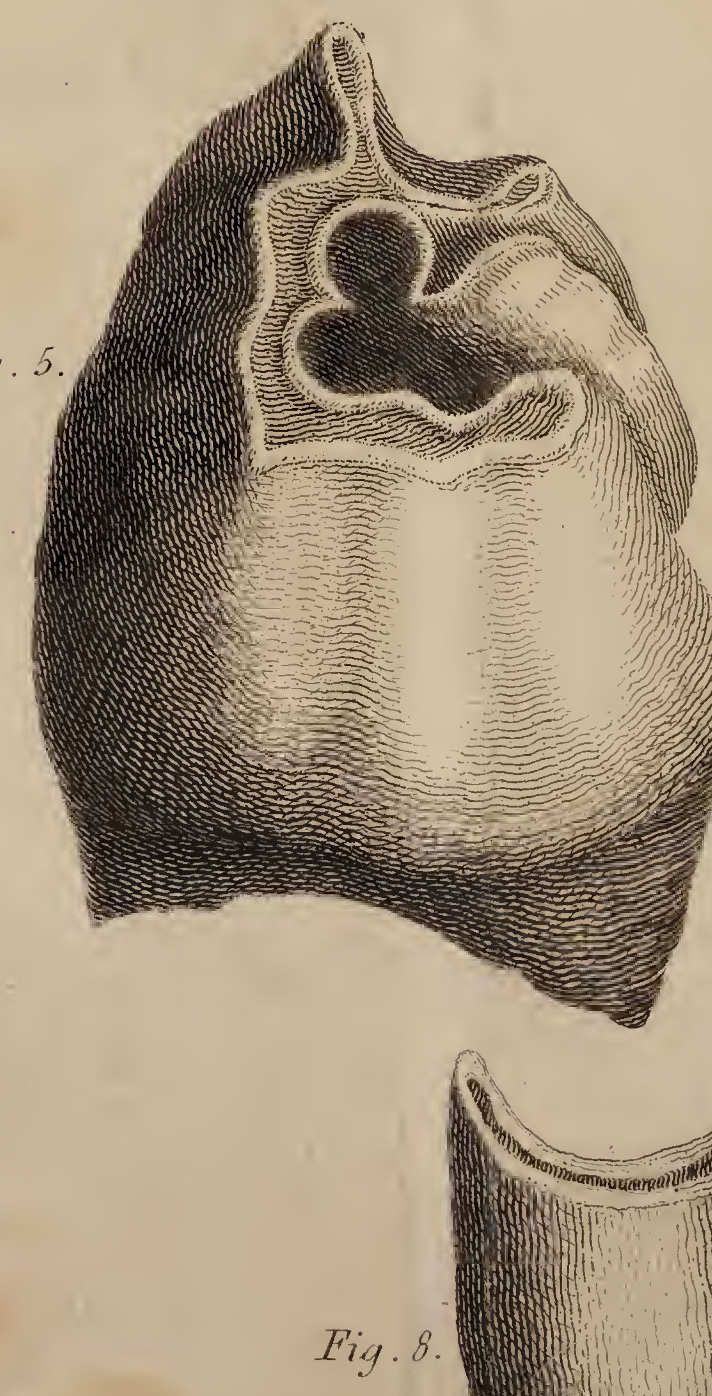


Fig. 6.

Fig. 7.

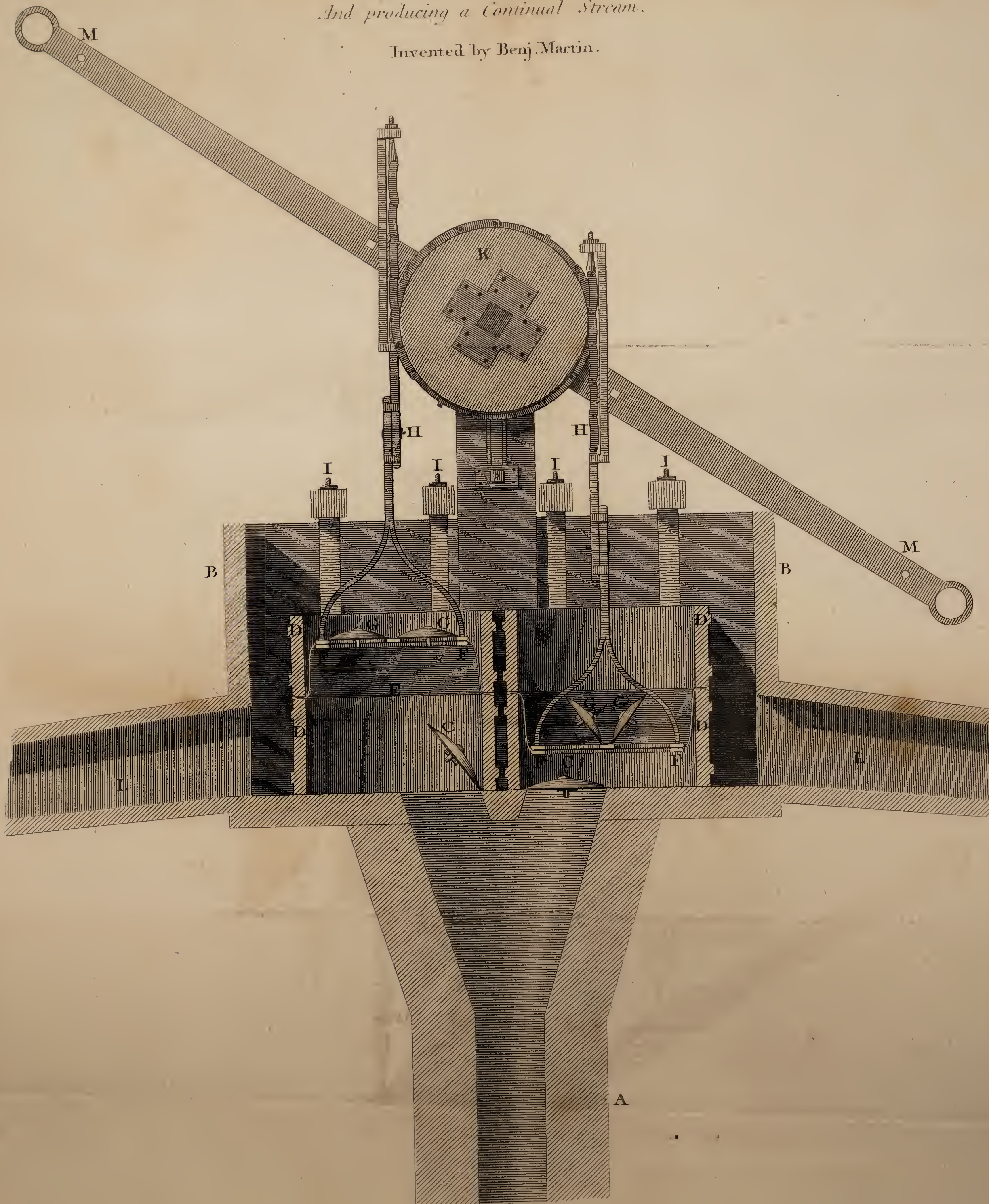
Fig. 8.

Jn. Lee sculp

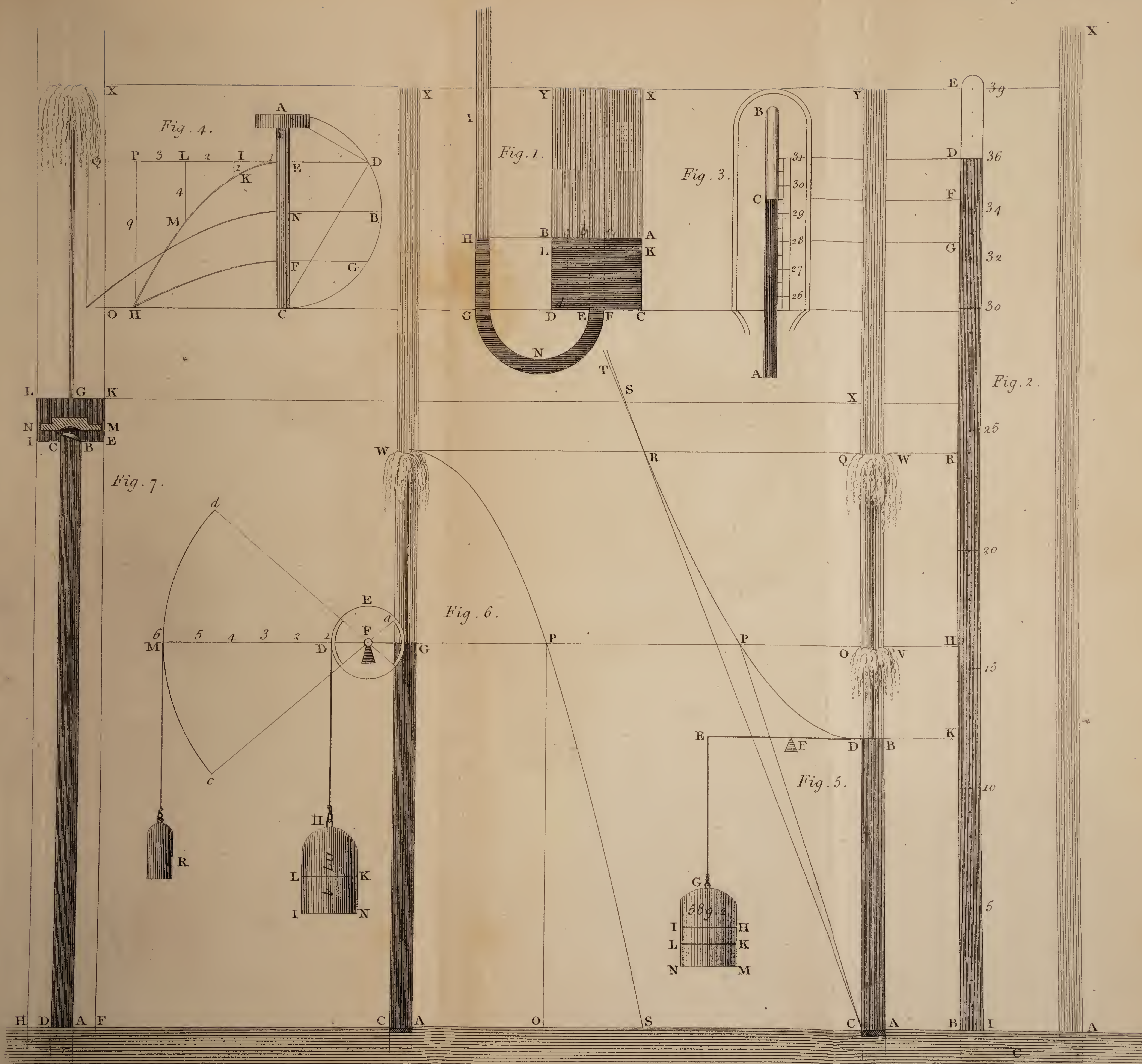
A SECTION of the PATENT PUMP without Friction,

And producing a Continual Stream.

Invented by Benj. Martin.

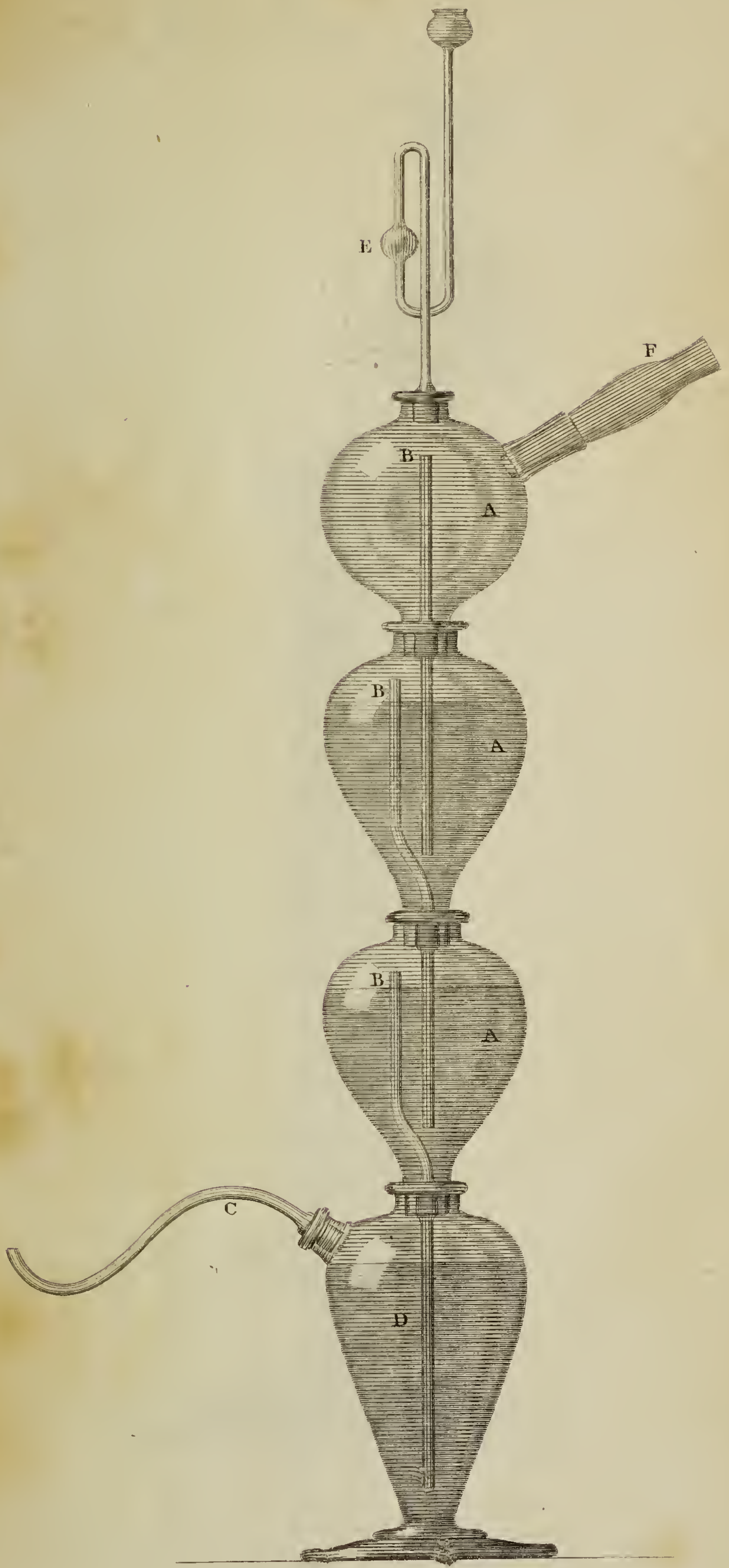


Lowry sc.



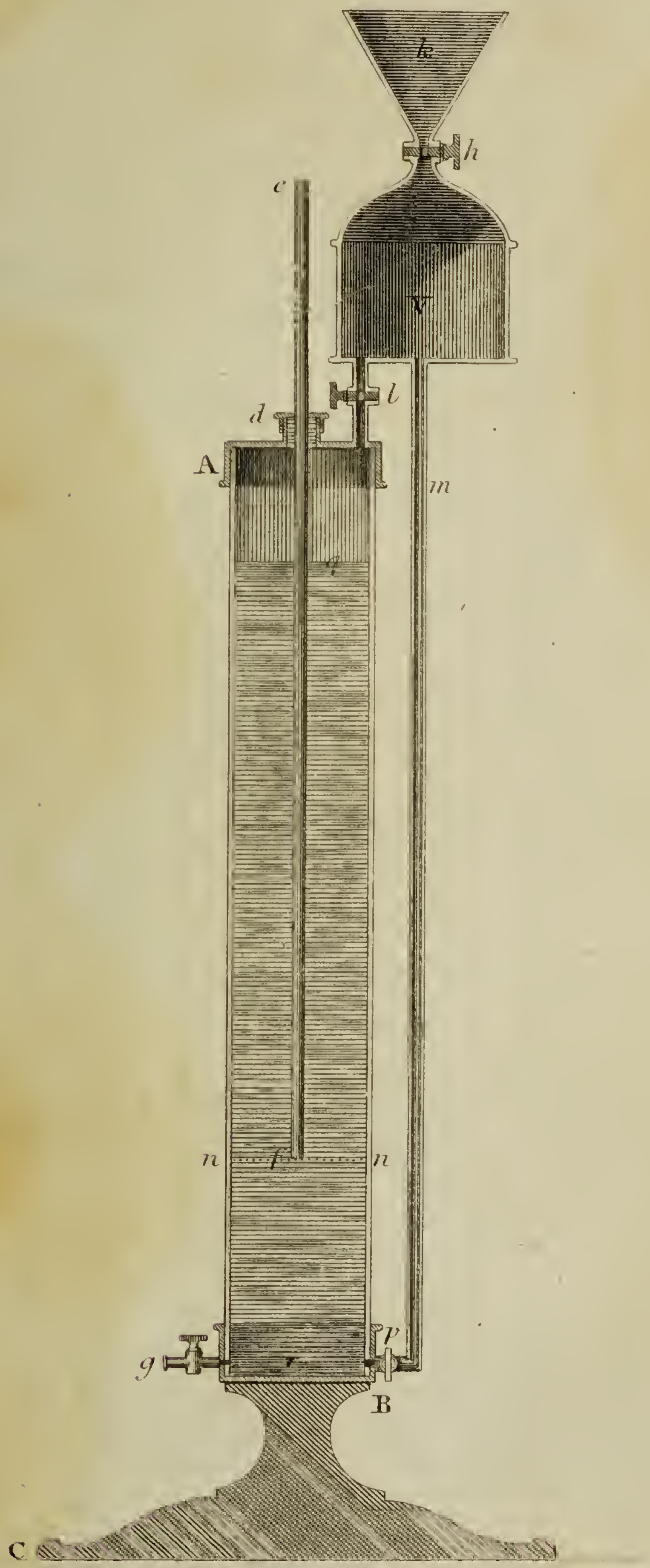
Lowry sculp.

Mr. KNIGHT'S IMPROVED WOULF'S APPARATUS.



Lowry sculp

Mr. Steevens's Instrument for equalizing the pressure & Efflux of non-elastic fluids.



Lowry sculp.